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New Design of the Tabor Indicator.

We present with this, perspective and sectional views of this instrument from an inspection of which a knowledge of its construction may be had. In our issue of May 8, 1880, we illustrated it as then and since made. A comparison of the engravings used at that time, with those in this issue, will show very clearly the improvements in construction which have been made, amounting virtually to the bringing out of a new, and, we think, greatly improved indicator.

In this instrument two important ends are attained, viz: an absolutely parallel movement of the pencil, and an equally correct vertical motion to the scale of the spring used. These are attained by simple means, which, we think, will commend themselves to the engineer and mechanic.

The pencil lever is guided in its up and down movement by a small roller free to revolve on a pin in the lever, and working in the guide slot shown. The outlines of this slot do not represent portions of a true circle, but parts of curves generated by a device similar in principle to the complete pencil movement of the instrument. This may be readily comprehended by imagining the pencil movement to be the arrangement for cutting the slot. Thus, if the roller which works in the slot were a cutter, suitably driven for forming the slot, and the pencil point constrained to move in a straight line, then the cutter would cut a slot of the required curvature. This guide to a parallel motion is simple, substantially frictionless, and should a renewal of the pin or roller ever be necessary it may be very easily accomplished. Its use throws no strain on the other parts of the instrument, and it is always open to the inspection of the operator.

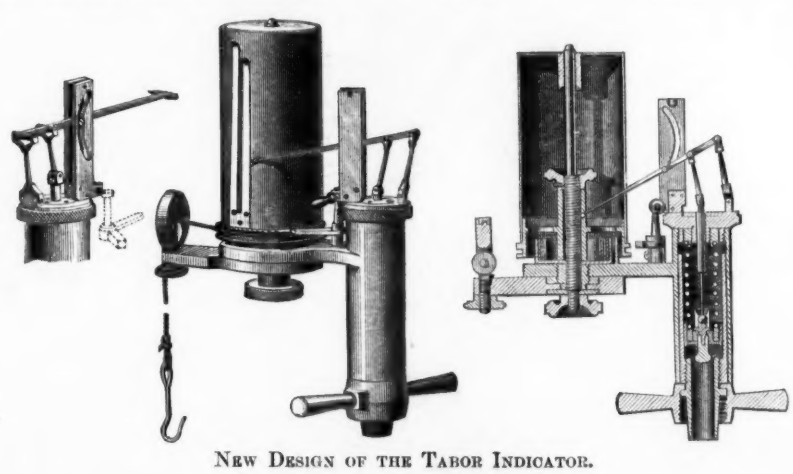
The correct vertical movement of the pencil, to correspond to the scale of spring, is obtained by the proper proportion of the lengths of the connections and links. The motion, in this respect, of every instrument made is thoroughly tested by the use of a micrometer screw, through the entire range of the pencil movement.

A ball-and-socket connection is made to the piston-rod at the bottom of the spring, which effectually avoids cramping the piston. The spring screws to the cover plate at its upper end, and the piston screws to the bottom of the spring. A small nut with a flattened projecting end (shown below the piston) checks the latter, holds it in place, and effectually takes up lost motion. In changing springs it is not necessary to remove this nut; no wrench is required in changing springs, in this respect the operation being much simplified over that necessary with the old instrument. The piston-rod ends in a hollow stem passing through the cover plate, to the upper end of which the link connecting with the pencil lever is pivoted. This hollow upper end keeps the weight light, and at the same time provides sufficient wearing surface.

This indicator, as now made, may almost instantly be changed from right to left, or *vice versa*. For this purpose the paper drum is turned partly around to a second slot for holding it from turning on its lower bearing, the guide or leading-off pulley reversed to the other side of the piece which carries it, and this piece reversed in position by being turned over.

The guide or leading-off pulley, and its mountings, are the invention of Mr. Calkins, superintendent in this department of the company's works. It is a remarkably neat and effective device. The pulley is carried in a circular disk encircled by a band. This band terminates in a round end, threaded for a nut, above which it is coned to fit in the bottom casting. The hole in this casting is coned from both sides, so the position of the pulley can be reversed, as previously described. By loosening the nut, the disk can be turned to any position around an entire circle, and by tightening the nut it is securely clamped in the desired position. This gives three adjustments to the guide-pulley, permitting the cord to be led off in any direction required.

Another improvement on this indicator is in the means of adjustment of the tension of the spring for the paper drum. By the means at present employed, this adjustment can be readily made in any degree, however small.



NEW DESIGN OF THE TABOR INDICATOR.

The motion of the pencil is five times that of the piston. The instruments are made either with or without stop-motion, as desired. All parts or pieces are interchangeable, special machinery being employed to that end. The springs are tested under steam pressure and heat, and accurately scaled.

The manufacturers are the Ashcroft Manufacturing Co., 111 Liberty street, New York.

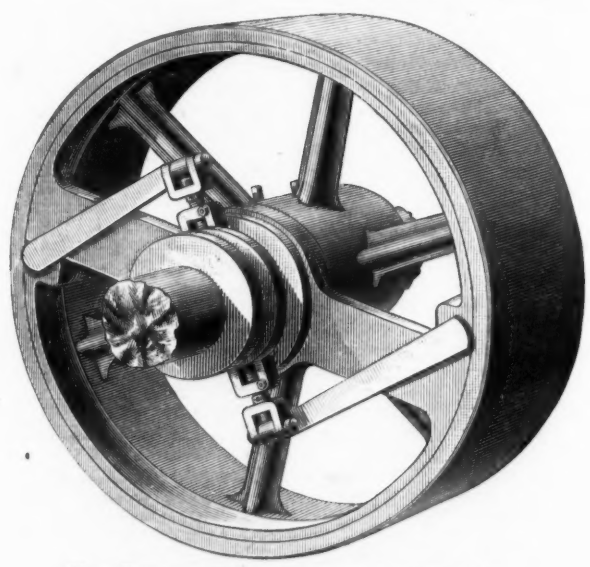
The Bennett Band Friction Pulley.

The friction pulley illustrated on this page possesses great strength and wearing surface. It is built by the Morris County Machine and Iron Company, Dover, N. J., for use in connection with their air compressors.

The hub being of a length equal to width of pulley face, and running on the outside of the fixed hub, it occupies no more space on the shaft than an ordinary pulley.

The leverage in the locking device is very powerful, with but slight outlay of arm force. The power of the levers increases greatly as the toggle links come to their locking position under the levers, without requiring an increase of force to get them there. It is claimed that there is an absence of all end thrust on the shaft or pulley, and adjustability for wear is provided in the links as shown.

Fig. 1. shows the pulley in perspective, as it appears on a countershaft when locked for use. Figs. 2 and 3 (page 2) are end elevation and section views, showing construction. The oblong lugs on outer end of lever *G* pass through a corresponding slot *K*, where end of friction band is detached from arms *F*. When the inner end of the lever is moved out, the friction band is enlarged and forced out against inner surface of pulley, thereby locking the two. The entire operation is noiseless, and without jar, the starting being as gentle as could be desired.



THE BENNETT BAND FRICTION PULLEY—FIG. 1.

A Well-Known Engineer's Views Upon the Brooklyn Bridge Disaster.

[Elsewhere in this issue we call attention editorially to the above subject under the heading, "Railroading on the Brooklyn Bridge," and point out a practical initial step which should be taken by the Trustees to prevent a large and steadily increasing number of human lives from being put to daily hazard.

Below will be found a communication which we commend to the special attention of mechanical engineers and mechanics generally:]

Editor American Machinist:

Having been professionally employed within the last year to examine the grip used on the bridge, I have obtained some knowledge of the subject, which enables me to accede to your request, and present the mechanical features of this case, to which attention is now so anxiously directed.

I should first mention the curious fact that, on the morning after the late accident, the daily press very generally agreed in calling attention away from its real cause, and attributing it to the want of proper terminal facilities on the New York side, when the accident occurred on the Brooklyn incline.

The idea lying at the bottom of the Paine grip is an excellent one. This is, to avoid injury to the cable from running through the jaws of a grip, while these jaws are being closed upon it, and the car is either at rest, or is being gradually put in motion. The Paine grip consists of two pairs of wheels, which are closed on the cable. As soon as these touch the cable they begin to revolve, and the periphery of the wheel and the cable move together. Then an increase of the pressure tightens brake-blocks located inside the rim of each wheel, increasing also the force with which the cable is seized between the wheels. As the resistance of the brakes arrests the revolution of the wheels, the car receives the motion which the wheels lose, and when the latter are brought to rest, the car has the full motion of the cable.

This elegant and fascinating system was found, however, in practice, in the form in which it was embodied by Col. Paine, as above described, to be wanting in power, as well as in security against losing the hold on the cable. The requirements of the bridge traffic are very severe. The cars are large, and can hold standing, inside and on the platforms, four passengers in addition to each one they will seat, and the inclines up which they are drawn are 3½ feet in 100 feet.

It is obvious that, in order to be reliable, a grip should not only be certain to retain its hold on the cable, but should possess a reserve of power to seize the cable—should have the ability to grasp the cable with a force much beyond that which it is necessary to employ.

Under the exactions of the bridge traffic it was found impossible to make the Paine grip always answer, even when, as was the regular practice, it was strained to its utmost capacity. The difficulty was greatest in wet weather. It was found necessary to make the periphery of the wheels of leather, which, when moist, often failed to hold the cable from either slipping or being pulled by

the downward stress out of the grasp of the wheels.

To remedy these defects, an auxiliary grip, consisting of a pair of solid dies, has been added to the original Paine grip. These dies are intended to be closed on the cable after the cars have attained their full motion, but before they begin to ascend the incline. This was another excellent idea. But a difficulty existed in the way of its practical application. The obvious way of operating this auxiliary grip would be by means of an independent hand-wheel and chain and system of levers. These, however, would introduce so much complication, as to be inadmissible, and so one connection is made to operate both the wheels and the solid jaws. But, to save the cable, the latter must not seize it until the car has got its motion. One movement then must first bring the wheels together, with force sufficient to get up the speed on a level track, and then must bring the solid jaws into action. Every mechanic will see that this presents a problem of exceeding difficulty. It is probable that the accidents which have occurred lately have been occasioned by the failure of the auxiliary grip to perform its function.

In spite of this failure, however, this accident would have been prevented if the brakes on the first and second trains had not failed to work. The powerful atmospheric brakes with which the cars are provided, are ample to hold them, and have doubtless prevented many accidents; but this time the failure of the grip was supplemented by the failure of the brakes.

The brake is worked by the same hand-wheel by which the grip is operated, it being necessary for the brakeman to change the connection. In this case something prevented this being done.

It would seem as if a very earnest inquiry ought to be made, in a case where human life is at stake, for something more reliable than the present devices, which present a complication that every mechanical engineer will say ought by all means to be avoided.

CHARLES T. PORTER.

In many places bevel gears may be replaced by belts and pulleys, but they should be so arranged that the shafting can run in either direction, and not run the belts off the pulleys.

In a recent address by Prof. Thurston, of Cornell University, delivered at Scranton, Pa., he said:

"At Bloomfield, New Jersey, the authorities are introducing most successfully a course of instruction of both boys and girls in the use of tools into their public school system. A manual training school affords a means of rewarding merit at Girard College, where the best students and most promising youth are admitted into the wood-working and machine shops under instruction, and there, under the careful and skillful tuition of expert mechanics, I have seen boys of twelve doing work at the vise with hammer and chisel and file that many an old workman might be glad to rival. The city of Chicago has a manual training school; at St. Louis, Washington University is doing excellent work in well appointed shops. Boston, in her great Institute of Technology, beside the classes of aspirant mechanical engineers, has organized other classes of boys ambitious to learn the use of tools, and is cultivating the special Yankee talent in a systematic and fruitful manner; and all over the country these primary technical schools are springing up.

"A year or more ago, I received a letter from a capable and successful superintendent of schools in a Western city, saying that he had seen plainly the approach of the new era in primary education of the people for the work and life of the people, and desired to be ready for its advent in his own city, and asking to be instructed that he might intelligently direct the changes of method and system inevitably to come in his own organization. He came East and worked in the shop and studied under instructors all summer to obtain the requisite knowledge and skill. Fortunately, he proved a natural mechanic, and an extraordinarily capable man, and he is now ready to lead in the movement when the looked-for time shall arrive.

"Trade schools now form a part of every school of engineering, and schools of engineering are springing up all over the land.'

Horse-power of Boilers.

The following data for rating boilers are given in the *Steam Users' Journal:*

With good natural draught, flue boilers should have about 10 square feet of heating surface for the evaporation of 1 cubic foot of water per hour; and this evaporation per hour may be taken to represent 1 horse-power.

The coal required to effect this evaporation will generally be about 8 lbs., and the grate surface provided for the combustion of this amount of coal per hour, should be about half a square foot. Therefore, for each horse-power that a flue boiler is expected to develop economically, the following will be required:

10 square feet of heating surface.
½ square foot of grate surface.
1 cubic foot of water per hour.
8 pounds of good coal per hour.

Proved Her Value.

Some years ago a gentleman in Iowa, who was well known as a successful agriculturist and agitator in favor of granger legislation, became possessed of a desire to figure as a railroad magnate. He projected a railroad that was intended as a rival to existing lines. Believing that a good railroad could be built at one-tenth the cost usually represented as the expense of railroad construction, this agriculturist proceeded to demonstrate his ability as a railroad builder, and he succeeded in getting a few miles of track in running order. All the material used was old second-hand stuff that established roads could no longer use, and he succeeded in building a cheap road so far as it went. A connecting road had an old locomotive which was popularly known as the "Mud Hen," owing to her propensity for the ditch. This locomotive the agriculturist bought to operate his road. Shortly after the purchase had been made, a friend who had some knowledge of machinery, and did not approve of the Mud Hen purchase, ventured to expostulate with the new owner. "Not a good engine, did you say?" he replied; "you must be mistaken. The Rock Island Railroad would never have kept an engine twenty-five years if she had not been a good one."—*National Car Builder.*

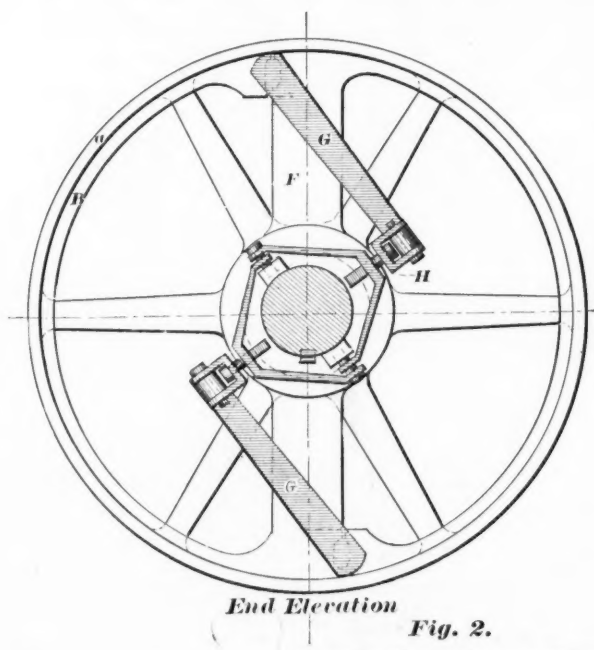


Fig. 2.

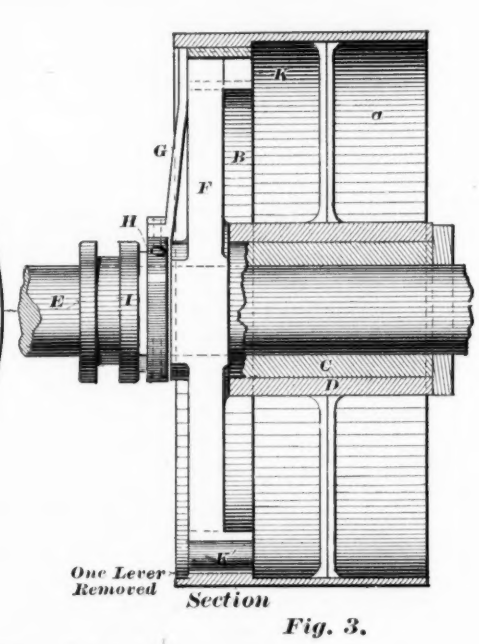


Fig. 3.

BENNETT BAND FRICTION PULLEY. See Page 1.

Efficiency of Gear Teeth.

BY GEORGE B. GRANT, BOSTON.

There is great lack of uniformity, often amounting to controversy, in the practice and the opinion of the mechanical world, with regard to the proper curve to be used for the working faces of gear teeth, and the result is confusion in a matter that is subject to exact mathematical laws, and that should be as fixed and uniform.

The two curves, of the many possible ones, that are mostly in use, are the epicycloid and the involute, of which the former is in most general use and favor for heavy work, cast gears, mortise gears, and heavy planed gears, as well as for some descriptions of small work, such as clock and watch gears.

Some concerns use neither of the regular curves, but adopt a private nondescript affair that is sometimes kept a profound secret. But these are, happily, so few in number, that they need not be further considered.

Again, some prefer the radial flank non-interchangeable form of epicycloid with the evident idea that it is the best possible system.

To increase the efficiency, but really to increase nothing but the confusion, already great enough, the base of the interchangeable epicycloidal system has been changed from the prevailing standard of twelve teeth to one of fifteen teeth.

The two curves may be compared with respect to several features, but I will confine this inquiry to one point only, and compare them with respect to efficiency and waste of power by friction.

The main argument of the advocates of the epicycloid is that its efficiency is greater, and loss of power by friction less than for the involute, an argument that appears to rest on the slim support that at the line of centers its direct pressure and actual force of friction is the least. No comparison can be made at the line of centers, for at that point there is no sliding action and consequently no loss of power by friction with either curve. At that point they are of equal and perfect efficiency.

The fairest measure, for purposes of comparison of the efficiency of a gear tooth, is the work done by friction while the point of contact of one pair of teeth is passing from the line of centers over one-half a tooth. There cannot be less than one pair of teeth in action, and if there are more they help each other and divide the work. A half tooth on one side of the line of centers is taken for the sake of simplicity, for the work done over the same arc from the line of centers, is the same on either side, varying only with the coefficient of friction. If more than a half tooth is taken, the result is to increase the comparison in favor of the involute.

The friction of gear teeth on each other is compound, for there is both sliding and rolling action, but the friction of rolling contact is so small that we can neglect it.

The work done by the sliding of one body on another is the product of three factors, the direct or normal force acting between the bodies, the coefficient of friction for the material in use, and the length of the sliding action or whole distance over which the resistance of friction is overcome.

The problem will be more easily handled if we first try a graphical solution.

Fig. 3 (page 3) shows the graphical process for finding the approximate work lost by an epicycloidal tooth. Let $O K = k$ and $O H = h$ be the two pitch radii, $O R = r$ the radius of the generating circle, and $O P = P$ the tangential force at the pitch line.

At any instant, when the point of contact has moved from O to the position A, which must be on the generating circle, the pitch point of one curve has moved to B, and that of the other to G, the circular arcs $O A$, $O G$, and $O B$ being of the same length. The curves $A G$ and $A B$ must then be drawn and an arc $A D$ laid off on $A B$, equal in length to the arc $A G$.

The normal force acting between the teeth, pressing them together at their point of contact, is the force $O S = S$, found by drawing a line $P S$ parallel to $H K$, and as this force varies in amount from $O P$ to $O S$ its average may be taken as

$$OS' = \frac{OP + OS}{2}$$

The force of friction F, or its average F', may be taken as a certain part of the direct force, about one-tenth to one-sixth for unlubricated cast iron teeth.

While moving from O to A, the two teeth have rubbed on each other over the distance $D B$, which is the difference between the lengths of the curves $A B$ and $A G$, and they have rolled on each other, with little friction, over the distance $A D$.

To find E, the approximate work done, multiply the distance $O F'$ by the distance $D B$.

The involute, Fig. 2, is drawn in the same general way, except that the path of contact is not a fixed circular arc, but a fixed straight line $O S$, and that the normal force has the constant value $O S$.

The results of the most carefully made drawings on a large scale will be:

1st. That E, the work done by the epicycloid, is practically equal to I, the work done by the involute, for an arc $O G$, on the pitch line about equal to, or less, than half the circular pitch.

2d. That for an arc $O G$, of considerably more than half the pitch, E is perceptibly greater than I.

3d. That I has the same value for the same arc $O G$, no matter what angle $A O H$ is chosen, and

4th. That the difference between E, for a base of 12 teeth, and the same for a base of 15 teeth, is not graphically perceptible.

The graphical process clearly indicates the general results, but these results are so close that no graphical or experimental process can possibly show their real difference, and our only reliance for that purpose is on analysis.

For example, a carefully made drawing for $h=6$ $k=12$ $r=3$ $P=4$ $f=\frac{1}{4}$ $A O H=53°$ and a circular pitch of 3 14 gave the following results for three different arcs $O G=$ 1 57, 3.00, and 4 50.

	arc O G	1.57	3.00	4.50
Epicycloid.	average S	4.07	4.23	4.54
	curve D B	.27	1.06	2.38
	E measure	.275	1.12	2.70
	E calcu'n	.283	1.15	2.73
Involute.	S	4 98	4 98	4 98
	curve D B	.23	.88	2.00
	I measure	.285	1 10	2.49
	I calcu'n	.280	1.13	2.53

This table also shows that the approximate graphical results are within two or three per cent. of their exact calculated values.

The following analytical process is given in full, omitting only the simple processes of substitution and calculation.

In Fig. 1 the two gear teeth are of either the epicycloidal or involute or any other possible form, and they press against each other with a normal force S, at a point of contact that moves from the instantaneous center or pitch point O, to any point A, sliding on each other and doing work that varies in amount according to the pressure S, and the amount of the sliding action.

The condition of uniform velocity ratio, without regard to the form of tooth curve in use, requires the sliding motion at any point, A, to be for the instant over the elementary distance $A B$ at right angles with the line $A O$.

If the normal force is S, and the coefficient of friction is f, the resistance of friction is $f S$, and this, in moving over the distance $A B$, does the work.

$$W = f S \; A B$$

The normal force S is always the driving force $O P = P$ divided by the sine of the normal angle $A O H = M$.

$$S = \frac{P}{\sin M}$$

If the total arc of rotation of the point A about the instantaneous center O, while moving from O to A is the arc V, the elementary distance $A B$ will be its differential $d V$

multiplied by the distance $A\,O = b$, and the elementary work becomes

$$d\,W = f\,P\,\frac{b}{\sin M}\,d\,V$$

While the point of contact moves through the angle of rotation about O, whose elementary arc is $d\,V$, the wheel H will move through the elementary arc $d\,x$, and we have

$$d\,V = \frac{k \pm h}{k}\,d\,x$$

in which h is the pitch radius $O\,H$, and k is the radius $O\,K$, the positive sign is for external, and the negative for internal contact, so that the total work lost by friction from O to A is

$$W = f\,P\,\frac{k \pm h}{k}\int_o^x \frac{b\,dx}{\sin M} \qquad (1)$$

This is a general expression for the total work done by friction while the gear H is moving through the angle whose arc is x either way from its position when the point of contact is at the pitch point O, and its value cannot be further determined without choosing some particular tooth curve, and fixing the relation of the quantities M and b to x.

To apply this general expression we will first take the involute curve, Fig. 2.

The path of contact is here a straight line at the fixed angle $A\,O\,H = \boldsymbol{M}$ with the line of centers $H\,K$, and we have the normal force

$$S = \frac{P}{\sin M}$$

That is, the normal force between involutes is constant, not only in direction but in amount.

Again, the angle through which the wheel H has turned while the point of contact has moved from O to A is the angle $E\,H\,F$ through which the foot of the involute on the base line $Q\,F$ has turned, and as the arc $E\,F$ is equal to the line $A\,O = b$, we have x, the arc of the angle $E\,H\,F$ equal to

$$\frac{E\,F}{E\,H} = \frac{A\,O}{Q\,H} = \frac{b}{h \sin M}$$

and from that we get $b = h\,x \sin M$.

This value of b substituted in (1) gives its value for involute teeth

$$I = f\,P\,\frac{k \pm h}{k}\,h\int_o^x x\,d\,x$$

which becomes, when integrated,

$$I = f\,P\,\frac{k \pm h}{k}\,h\,\frac{x^2}{2}$$

and if we use the pitch arc,

$$w = h\,x.$$

$$I = \frac{f\,P}{2}\,\frac{k \pm h}{k\,h}\,w^2 \qquad (2)$$

This value of I does not contain the normal angle $\boldsymbol{M}$, and we have the singular fact that the work done by the friction of involute teeth is the same for all normal angles and for all interchangeable systems.

As is well known, it does not affect the uniformity of the velocity ratio of involute gears to vary their center distance, and from the above it is seen that the same variation does not affect the work lost by friction.

If, for the reasons above given, we confine the inquiry to a half tooth, we have

$$w = \frac{c}{2}$$

and

$$I = \frac{f\,P}{8}\,\frac{k \pm h}{k\,h}\,c^2 \qquad (3)$$

In the case of the epicycloid, Fig. 3, the conditions are different, for then the normal angle $\boldsymbol{M}$ is variable.

When the point of contact A is at the half-tooth point, and

$$w = \frac{c}{2}$$

we have

$$M = 90 - \frac{180}{s}$$

where s is the number of teeth in the base gear of the interchangeable system in use. As that is the constant value of $\boldsymbol{M}$ for the involute tooth, it follows that at the half-tooth point the epicycloid and the involute have the same normal pressure and the same normal angle for systems of the same base.

We have the arc AO = arc $GO = h\,x$, and

$$b = OA = 2r \sin ORD = 2r \sin \frac{h}{2\,r}\,x$$

where $r = OR$ is the radius of the generating circle, h the radius O H, and x the arc of the angle OHG. Again we have

$$\sin M = \sin DOR = \cos ORD = \cos \frac{h}{2r}\,x$$

and these values of b and M, substituted in (1) give us its value for epicycloidal teeth.

$$E = f\,P\,\frac{k \pm h}{k\,h}\,2r\int_o^x \tan \frac{h}{2r}\,x.\,dx$$

which integrates to

$$E = -f\,P\,\frac{k \pm h}{k\,h}\,4\,r^2\,\log.\cos.\frac{w}{r} \qquad (4)$$

For the interchangeable system whose base gear has s teeth, and for the arc

$$OG = \frac{c}{2}$$

this becomes

$$E = \left(\frac{f\,P}{8}\,\frac{k \pm h}{k\,h}\,c^2\right)\left(-\frac{2s^2}{\pi^2}\log\cos\frac{180^\circ}{s}\right) \qquad (5)$$

which is the value of the work done by the friction of an epicycloidal tooth over half a tooth from the line of centers.

By comparing (3) and (5), it is seen that the constant value of I is also one factor of E, and we can write the comparative equation

$$E = I\left(-\frac{2s^2}{\pi^2}\,\log.\,\cos.\,\frac{180^\circ}{s}\right) \qquad (6)$$

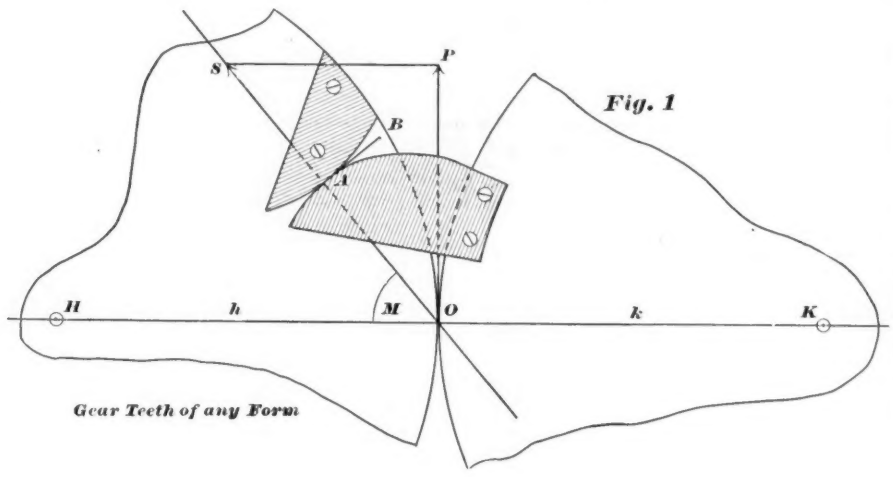


Fig. 1

Gear Teeth of any Form

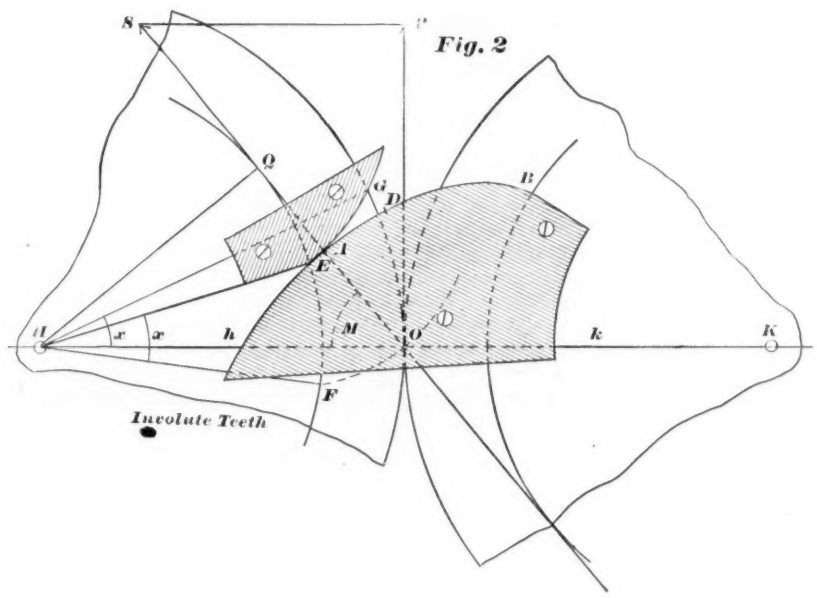


Fig. 2

Involute Teeth

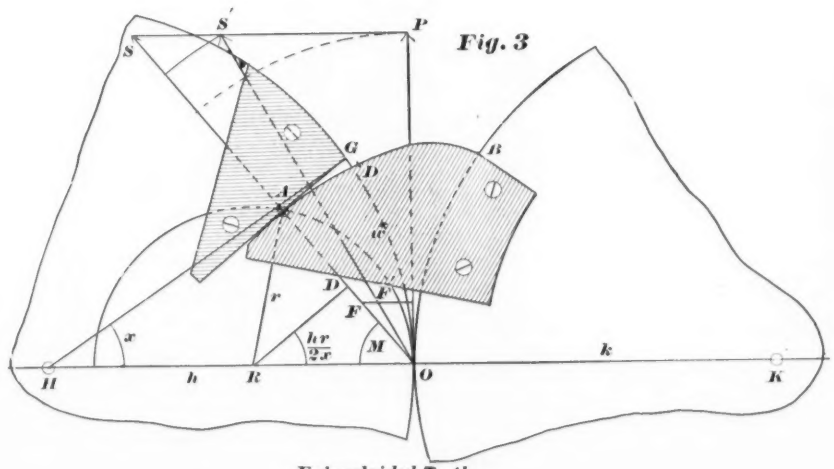


Fig. 3

Epicycloidal Teeth

As

$$\log.\cos.\frac{180^\circ}{s}$$

is always negative, the second factor of (6) is positive, and it is an integer that decreases in amount, until, for $s = \infty$, it becomes unity. Now, the epicycloid for $s = \infty$ is an involute, and therefore the equation shows that E is always greater than I, the comparison being more in favor of the involute as s decreases in amount.

To compare E and I, give s several values.

$s = 3$	$E = I \times 1.2641.$
$s = 6$	$E = I \times 1.0494.$
$s = 12$	$E = I \times 1.0116.$
$s = 15$	$E = I \times 1.0074.$
$s = 100$	$E = I \times 1.0004.$
$s = \infty$	$E = I \times 1.0000.$

and a study of these figures will develop several facts as follows:

1st. The work done by the friction of an involute tooth is always less than the same work for any possible epicycloidal tooth.

2d. With respect to work done by friction, a change of the base from a gear of 12 teeth to one of 15 teeth, makes an improvement for the epicycloid of less than one-half of one per cent.

3d. For the 12-tooth system the involute has an advantage of $1\frac{1}{2}$ per cent., and for the 15-tooth system an advantage of $\frac{1}{4}$ per cent.

4th. That a maximum improvement of about one per cent. can be accomplished by the adoption of any possible non-interchangeable radial flank tooth, in preference to the 12-tooth interchangeable system.

5th. That for gears of very few teeth the involute has a decided advantage.

6th. And that the common opinion among millwrights and the mechanical public in general, in favor of the epicycloid, is a prejudice that is founded on long continued custom, and not on an intimate knowledge of the properties of that curve.

If we wish to compare the two curves for any arc of contact, we put $w = nc$ in (2) and (4) and have

$$E = I\left(-\frac{s^2}{2n^2\,\pi^2}\,\log.\,\cos.\,2n\,\frac{\pi}{s}\right)$$

We cannot have n less than $\frac{1}{2}$ on a single gear, and if we put it more than that we increase E. If we put $n = 1$ and $s = 12$ we have the work done over a whole tooth-arc from the line of centers,

$$E = I \times 1.0494,$$

so that to consider more than a half tooth-arc will increase the comparison in favor of the involute.

In the case of stepped gears, where two or more gears are placed side by side with teeth lapped, we can put n less than $\frac{1}{2}$, but not less than $\frac{1}{2\,g}$, where g is the number of gears in the set.

This gives

$$E = I\left(-\frac{2\,s^2\,g^2}{\pi^2}\,\log.\,\cos.\,\frac{\pi}{g\,s}\right) \qquad (8)$$

which becomes for $s = 12$ and $g = 12$

$$E = I \times 1.0004$$

so that the device of a large number of stepped gears does not give the advantage to the epicycloid.

If the number of gears in the set is infinite, it becomes a spiral gear, and in that case we have

$$E = I$$

and it makes no difference which curve is used.

The smooth and efficient action of internal gearing is easily explained by (3) and (5) which show that if A is the work done by external gearing, and B is the same work when the larger gear is internal, we have

$$\frac{A}{B} = \frac{k+h}{k-h} \qquad (10)$$

If

$$k = 2\,h, \qquad \frac{A}{B} = 3$$

That is, if the gear is twice the size of the pinion, three times as much power will be lost by external as by internal gearing. Similarly if

$$k = 1\tfrac{1}{4}\,h, \qquad \frac{A}{B} = 9$$

and if

$$k = 100\,h \qquad \frac{A}{B} = \frac{101}{99}$$

and the gain in efficiency will be greater as the gears are nearer the same size.

Small improvement can be made by putting a small pinion inside rather than outside a large gear, as is often done on large face plate lathes and boring mills. A six-inch pinion and a six-foot gear will give

$$\frac{A}{B} = \frac{13}{11} = 1.18$$

an advantage of no great value.

The actual efficiency of a gear tooth is the work transmitted, divided by the work received.

The work received is the force P, acting over the distance $\frac{c}{2}$, or

$$W = P\,\frac{c}{2}$$

the work transmitted is I or E, and the efficiency is

$$I' = 1 - \frac{f\,c}{4}\,\frac{k \pm h}{k\,h}$$

for the involute, and

$$E' = 1 - \frac{f\,c}{4}\,\frac{k \pm h}{k\,h}\left(-\frac{2\,s^2}{\pi^2}\log.\,\cos.\,\frac{180^\circ}{s}\right)$$

for the epicycloid, and we have

$$E' = 1 - \left(1 - I'\right)\left(-\frac{2\,s^2}{\pi^2}\log.\,\cos.\,\frac{180^\circ}{s}\right)$$

and for several values of s this latter becomes

$s = 12$ $\quad E' = 1.0116\,I' - .0116.$
$s = 15$ $\quad E' = 1.0074\,I' - .0074.$

Formulas (3) and (5) show that for either form of tooth the work done by friction varies as the square of the circular pitch. To double the size of the tooth, is to quadruple the waste of power. As the face of the gear has nothing to do with the lost work, it is much better to gain strength by increasing the face than by increasing the size of the tooth. The tooth should be as small as is consistent with its required strength.

Epicycloidal teeth are often said to have a smoother action than involute teeth, but the smoothness of the action of gear teeth may be said to depend as much on the effect of friction as on anything else except the accuracy of the formation of the curves, and of the spacing of the teeth.

Involute gears certainly have a smoother action than epicycloidal gears of the same accuracy of construction, for their efficiency in the use of power is greater, the normal force between the teeth is more uniform in amount and in direction; the sudden change in the direction of the force of friction which takes place at the line of centers is exactly the same, and there are no other features that can be considered in the comparison.

If gear teeth of either form are accurately formed and spaced, the bearings nicely fitted, and the frame stiff enough to stand the strain, they will come together gradually and easily, without shock. Smoothness of action is a matter of workmanship, and depends very little on the form of the tooth.

The involute is superior to and not inferior to the epicycloid with respect to efficiency in the transmission of power, as well as in many other respects.

Setting Up Cast-Iron Steam Pipe—Making Short Lengths—Screwing Up Bolts Under Steam Pressure—Using a Monkey Wrench.

BY JAMES F. HOBART.

In running a line of cast-iron steam pipe, it often becomes necessary to use short lengths. Usually ordinary cast-iron steam pipe of 6″ or less in diameter is made in lengths of about six feet. When a 2-foot length is needed, and it is not convenient to get special lengths cast, the usual practice is to cut the pipe in a lathe, thread it, and screw on a flange which has been bored and threaded to fit the threaded pipe.

We have often avoided the delay of the above method by simply bringing the end of the cut pipe against the flange of the next whole length, and putting in bolts long enough to reach the whole length of the short pipe, and pass through the flanges of the two pipes adjoining the short piece. The usual rubber gasket must be put between the cut end of the short pipe and the flange next to it.

The pipe may be cut off in a lathe, if one is accessible, or it may be nicked around with a sharp cold-chisel, and then broken by dropping upon a block. In this case the broken end of pipe must be filed up true and smooth before being bolted as described.

We used to do a dangerous trick when putting up cast-iron steam pipe. We would let on steam and then tighten up some of the bolts in order to stop leaks in the joints. One day a bolt broke, the joint opened and steam rushed out.

We escaped with slight burns, a big scare, and a practical lesson that it is not safe to tighten bolts which are under steam pressure.

One other point about this bolt and monkey-wrench business: When we go to a machine to screw home a loose nut or set-screw, we always calculate where we can jump to if the wrench slips off.

Perhaps we are on a ladder, or doubled up between the arms of a pulley; in either case we study out where that wrench is going if it slips off the nut or screw head. Many a broken nose or awkward tumble may be saved if one will do a little calculating before he throws his weight on a wrench.

A New Expanding Mandrel.

Among small special tools used with good effect in the shops of the Chicago, Alton and St. Louis Railroad, at Bloomington, Ill., says the *National Car Builder*, is a set of expanding mandrels invented by Mr. John G. Pope, one of the foremen. This mandrel consists of a square threaded screw with three slots or splines milled lengthwise at equal distances apart. A tapered key fits into each spline and slides in it. The thick ends of two of the keys are set at one end of the screw, and the thick end of the other key at the opposite end. Nuts are used to advance these keys so that they wedge under work placed on the middle of the mandrel. The screw mandrel is placed between the centers of a lathe. Glands and all sorts of collars are turned very rapidly and accurately on these mandrels. The same man got out a special tool for cutting holes in flue sheets. It will cut a 2-inch hole through a ½-inch steel sheet in three minutes.

The Boston and Lowell Railroad has recently been trying a new arrangement for ventilating cars, the invention of William Ober, of Salem, Mass. By his arrangement a fan is driven from one of the car axles; this forces the air through water to relieve it of dirt, when it passes along the car in a duct, and up and into the car through small pipes reaching above the tops of the seats. The tops of these pipes are provided with flaring mouthpieces which may be turned in any direction, or any of the pipes may be closed entirely. In the trials the ventilator is said to have worked entirely satisfactorily.

Draining Steam Pipes by Trapping.

BY O. C. WOOLSON.

The remarks by J. J. Bingley in the AMERICAN MACHINIST of December 12, about draining the dry and steam pipes of locomotives, are well put. I would like to offer my own thoughts and experience in this direction, in connection with stationary apparatus. The matter of carrying off the condensed water which may be formed in pipes leading to and from steam-engines and steam-pumps receives too little attention as a rule. All piping should be placed so as to bring the drainage to some legitimate point, where it can be readily taken care of. It frequently happens that pockets will be formed somewhere in the line, in which case special drainage should be provided at such localities.

The practice of draining the exhaust pipes leading from steam machinery is not general, but we have adopted such a method, for I believe it the best. The saving of hot water and the heat of exhaust steam is an object in most places.

If it does not seem best to go to the extra expense of a regularly designed exhaust condenser, insert somewhere in the exhaust piping a 2 or 3-foot length of pipe, (a piece of old condemned steam pipe answers first rate) from 10 to 15 times the area of the exhaust pipe.

To obtain the best effect from the exhaust chamber thus formed, the exhaust pipe, which comes through the bottom head, should be continued up in the inside of the chamber. Put a short double bend close down to the head; then run a pipe up nearly to the top head of the chamber.

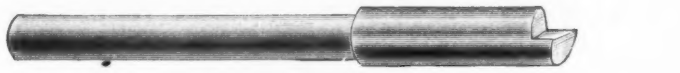
The pipe which leads out through the top, should start about 6″ or 8″ from the bottom of the chamber, which the bent pipes admit of, and run straight to the open air.

To the bottom of this chamber attach a small valve and drain-pipe and lead to the sewer, or, better still, to the cistern.

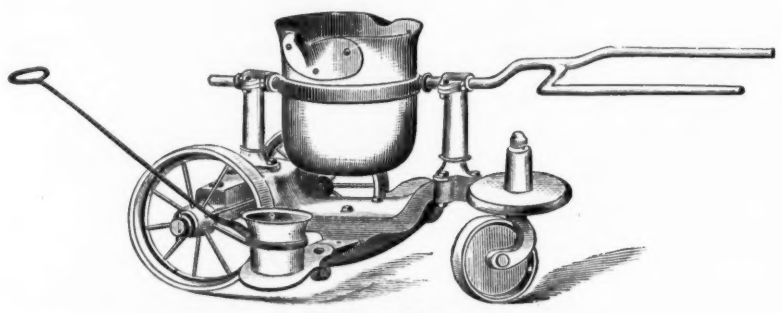
This will answer very well for an every-day plant, but we can go one step further with our exhaust system, and add but very little to the expense.

Put a valve just above the exhaust chamber, and instead of a small drain, put in the regular size exhaust pipe, with a valve, and run it to a cistern, which has been provided near the engine house, to catch and hold rain water. Put this exhaust pipe in such position, that it will throw the steam directly on to the water; it is not best to drive the end of the pipe under the surface of the water. To obviate this, as the height of the water varies, a swing pipe can be placed at cistern end, regulated at will, but this is rarely necessary.

There will be some steam left to find its way out of the cistern—so much the better—in winter time, at least, for this vapor will find its way to the leaders from the roofs, and keep them from freezing—an item of importance, usually.



CHUCKING REAMER.



FOUNDRY TRUCK.

Did you ever put up a nice new steam-pump which was provided with little nickel-plated pet cocks? Then, if it was not policy to drain from these beautiful pet cocks down over your dressed capstone and inlaid floor, you were obliged to cut a thread on one end of them and pipe to the cistern.

After a few days' run, you find those nice little pet cocks clogged up with sediment from the new boiler and pipes, and they have to be uncoupled and cleaned out.

BUFFING LATHE.

Our experience is, that the pet cocks usually furnished with a pump are not half large enough. It would be better to furnish none at all; simply give a good large tapped hole at each end of the cylinder, and we will pipe with as few bends as possible to get the drip into a large pipe leading into the cistern. A good globe-valve should be put as close to the cylinder as possible; also put a union near by.

Have the discharge from these drain pipes where it can be seen or heard, in order to tell whether steam and water pass freely; unless we do that, we are not absolutely sure they are not clogged up. This is important in the setting of fire-pumps.

It is usual to enter the side of a steam-chest by a nipple, valve and elbow; this elbow is out of place, and a tee should be used in its place. From the bottom of this tee run a pipe of the same size as the steam-pipe, down 6″ to 16″, with a reducer and a small valve, at the bottom of it then lead off to the system of drain-pipes.

This trap and its valve are doubly important when attached to a steam fire-pump. It is not good practice to send through the valves and cylinder the water of condensation formed in the pipes. This water is often filled with impurities which a trap such as I describe will catch. It costs a little thought and a little money, but it is economy to provide both.

The Cannon Chucking Reamer.

This does not claim to be a new tool, having been used for many years; but it has suffered neglect, and, we believe, does not appear upon the list of leading tool dealers. It will cut away stock very rapidly. If there were any escape for the chips it might even be used as a drill in solid stock. It cuts only upon one point, and this is as easily sharpened as a lathe tool. It fills the hole completely, and will not turn aside for soft or hard spots. Being sharpened only upon the end it preserves its size. If once accurately started it may be depended upon to produce a true hole. A line of these reamers is now being put upon the market by the Syracuse Twist Drill Co., Syracuse, N. Y.

Foundry Truck.

The accompanying engraving shows a very handy form of foundry truck, manufactured by Bradley & Co., Syracuse, N. Y. This truck has a capacity of about 600 pounds. The shape of the handles is such, that the helper, who handles the truck, can tip the ladle by his weight, leaving one hand free to skim. The illustration so clearly shows the construction and use of the truck that further description is unnecessary.

Combined Column Buffing Lathe and Belt Strapping Attachment.

The buffing lathe, herewith illustrated, is manufactured by the "Diamond" Emery Wheel and Machine Company, Providence, R. I. As shown in the engraving, the head stands 7¼″ from base to center of spindle, thus permitting the use of a 14″ wheel.

The strap polishing attachment can be removed and buff or solid wheels used on both ends if desired. This arrangement has the advantage of being quickly placed in position, and as readily removed. When changes of belts are required, it can be done almost instantly by slacking up the jointed standard, one end of which is firmly attached to the floor. Flanged pulleys are furnished; they are turned and balanced to run true.

Cone pulley on spindle is 3½–4½ inches diameter, 3¼-inch face. Countershaft has tight and loose pulleys 6 inches diameter, 3¼-inch face. Cone pulley, 11–12 inches diameter, 3¼-inch face.

The countershaft of this machine should run 430 revolutions per minute.

Arbitration in the Shoe Manufacturing Business.

Troubles between the Brockton shoe manufacturers and the labor organizations have been numerous, and the battles between them have been fiercely contested. Both sides to the controversies, realizing that money was wasted in these contests, concluded recently to make an effort in the direction of providing means of settling their differences. To this end delegates from the manufacturers and from the labor organizations met, and after a fourteen-hour session agreed upon a plan for adjusting their differ-

ences for a year to come. According to the plan adopted all differences are to be submitted to a board of arbitration consisting of six manufacturers and six workmen; in case they cannot agree, each side is to select a disinterested person, and these will select a third, and their decision will be final.

This plan is a wise one. The sentiment about there being no occasion for differences between employers and employes, is pure nonsense. Honest men always have differed and will always continue to differ, when they stand in the relation of buyer and seller. When these differences are between workmen and employers, the result is frequently serious, and it is the part of wisdom to provide means of settlement with the least possible amount of friction, and the least possible material loss.

LETTERS FROM PRACTICAL MEN.

Cylinder Packing.

Editor American Machinist:

Contradictory statements, experiences and beliefs, in regard to the results from the use of spring or steam-cylinder packing on locomotives of late, have caused me to recall some of my observations regarding this matter.

Packing rings in sections, or of the Congdon or Dunbar styles, or any packing that depends on springs of any kind to keep it "set," will not be considered in these remarks, as the simplicity, reduced first cost and maintenance of the common spring or steam ring have made it a favorite in this country.

The methods of making and using, and the styles employed, are very diversified; and much of the prejudice against this packing came from an experience with some style built or used upon wrong principles.

A common error is found in a ring like *A;* this ring is cut straight, or on an angle. As there is no dowel to hold it in place, and as the open part is the lightest, it will, in a few strokes, find its way to the top of the cylinder. As the weight of the piston keeps it down on the bottom, and as the bull-ring cannot *fit* the top of a cylinder which is out of round, the steam *blows* through the openings. I have seen this occur on a locomotive "just out," whose cylinders were not bad enough to re-bore.

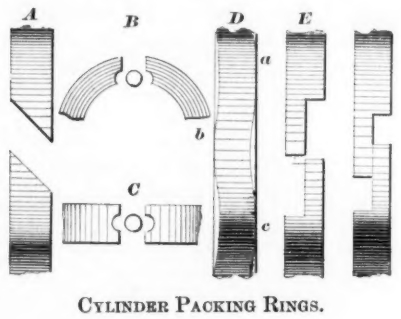
B and *C* are plans used to keep the opening of the rings in separate parts of the lower half of cylinder by using a dowel pin, and are good as far as they go, but are very expensive to make and keep in repair. My observation has been that most roads make a square ring, say $\frac{3}{4}''$ or $\frac{5}{8}''$. This seems pretty stiff at first sight, but provision must be made for wear on the sides of ring, for a ring might as well not fit the cylinder, as not fit the sides on follower or bull-ring. When spring rings get *down* they are *peened*, or hammered on the inside. This stretches the metal on the inside and enlarges the diameter, but seems to kill the metal, for rings peened two or three times have about as much spring as so much lead pipe. Right here this side-fit comes in hard, for if the rings are not peened even, they will be *snaky*, and if a little loose sideways will be like *D*, and touch at *a*, *b*, *c*. It is easy to see that steam can go down one open space, under the ring, and out the other side, while the ring is follower-bound.

Now my idea is a ring, say $\frac{3}{4}''$ wide and not over $\frac{1}{2}''$ thick, turned considerably larger than the cylinder, and milled on each side like *E;* when sprung together, as in right-hand cut, these rings make a steam-tight joint all around the cylinder and do away with dowel pins. The joint may go to the top, but there is no gap there; again, the ring is thin, steam goes in at the cut and forces the ring out to fit the cylinder more easily if it is out of round.

I have never seen this style of ring in a locomotive, but have in stationary engines. I do not know but that they are in use on some roads, and I expect somebody will write next week that this ring is old, like the chap with that countershaft brake; I only said it was new to me.

I should like to try a solid piston-head. The only good objection, to the solid head is, that it cannot be raised in the cylinder, and when it wears down, it remains out of the center to the detriment of all parts concerned. A common piston is an expensive thing; there is a spider, a follower, and a bull-ring; three castings, four cast-brass nuts, four forged bolts (some makers use five or six), and a hatful of liners to put between the end of spokes, legs, lugs or arms of spider and the bull-ring; by shifting these, the piston may be kept in the center of the bore or nearly so.

Now, why not use a plain, solid head, and shrink or forge a ring on the piston of $\frac{3}{4}''$ square rod, turn it up with the same and



CYLINDER PACKING RINGS.

countersink the head to receive it. After the hole is bored out and countersunk, shift the work in the lathe $\frac{1}{4}''$ or $\frac{3}{8}''$, run a cut through and mark over this cut "top or T." Put the piston-rod in to fit the lower side or center, and a heavy brass nut will hold all in place, as it does now; then by slacking the nut, the head can be raised easier and in half the time it takes now, and the collar always forms a steam-tight cover for the slotted hole; there are no follower-bolts to work loose and smash everything; it costs less than the old spider alone, and if the rings were made like *E* they could be easily sprung in; if the rings were turned to two or three standard sizes, the grooves could be trued up several times in their lifetime, and the rings refitted. A head worn out on a large engine, only needs to be put down in size and re-grooved, to be good as new for a small cylinder. A small steel set-screw might be run through the big nut, on side of the hole, as an extra precaution, if thought necessary. The road on which I am employed is trying a wrought iron solid head, but while the rings remain smooth, the head itself seems to cut the cylinder, and there is no way to raise the head.

I expect to be severely criticised, but hope your readers will think of the great difference in first cost and maintenance. I write simply as a thinking locomotive engineer, who would rather think incorrectly, than not at all. J. A. HILL.

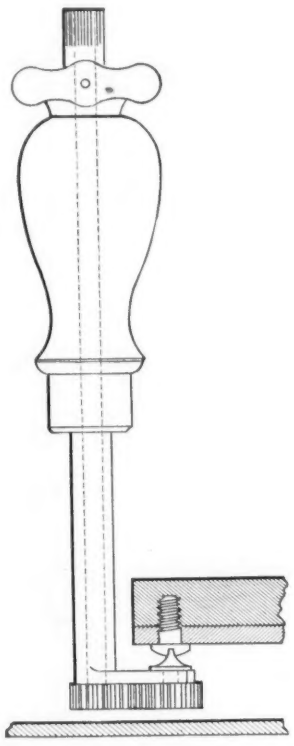
So. Pueblo, Col.

Laying Out Goose-Neck Attached to a Dome.

Editor American Machinist:

From George Marshall's paper on "Laying Out Sheet Iron and Boiler Work," in the AMERICAN MACHINIST of November 11th, I understand that the largest end of goose-neck is to be attached to a dome, that the smallest is to be connected to a pipe, and that both are circular in outline. If my supposition is correct, then, since the axis of cone is oblique to the plane of the curve, the cone must be elliptical in a section which is a right angle to its axis.

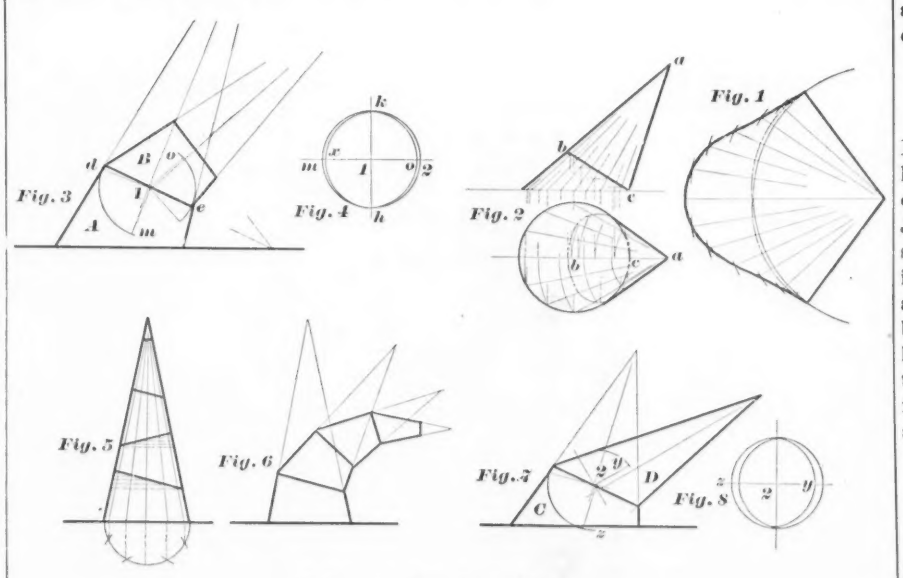
It is evident that the elements of this cone must be of different lengths, and that the development of its base cannot therefore be



SCREW-DRIVER.

an arc of a circle. The development of such an elliptical cone is shown in Fig. 1. Upon this development is drawn in dot and dash lines the development of base of right elliptical cone, shown in Fig. 2, by *a b c*. This line can be compared with the arc beside it, which shows what the development of base would be were the right cone circular, instead of elliptical.

The development of an elliptical cone can be obtained, as shown in Fig. 2, by dividing



LAYING OUT GOOSE NECK.

its surface into plane triangles so small that they practically coincide with the convex surface. Finding the true dimensions of these triangles, they may be added to one another, and thus the development of entire convex surface be obtained. But, supposing that the outline of larger end of cone *A*, Fig. 3, is elliptical, and that the section at right angles to axis of cone is a circle, then it is evident that the two cones, *A* and *B*, must be cut in the same elliptical section by the plane *d e*. Now, two cones cannot be assumed and have their curves true, as will be seen from Fig. 4, in which *h 2 k m* is the ellipse given by the plane intersecting *A*. This ellipse is very nearly a circle, since the plane *d e* is nearly perpendicular to axis of cone. The ellipse *h o k x* is the line in which *B* is intersected by plane *d e*, and it is seen that its short diameter *o x* is less than the short diameter 2 *m* of the other ellipse, and it is also evident that *A*, Fig. 3, must project beyond *B*. Hence it follows that if *A* is a true cone *B* must be elliptical in section.

The third piece would also be elliptical, and the fourth would probably be a warped surface, whose development may be obtained in a manner similar to that of the elliptical cone.

The goose-neck may be very simply obtained, both ends being circular, by taking any true cone, as shown by Fig. 5, and intersecting it by planes in such a manner that the different parts of the cone may be revolved about one another until they give the desired form of neck shown in Fig. 6.

The development of the different parts will be obtained by marking off, on the development of entire right cone, the length of the elements from the vertex to the different sections, these lengths being obtained as explained by Mr. Marshall, and as shown by him.

The method described by Mr. Marshall, although seemingly incorrect in principle, will probably give a result which may be near enough in practice, when the sections are not far from perpendicular to the axes, and the cones have about the same obliquity. The discrepancy will increase the more these conditions are departed from, as shown by Figs. 7 and 8. Fig. 7 assumes two true cones, *C* and *D*. Fig. 8 compares the sections, and shows that the section of *D* is smaller than that of *C*.

ANSON K. CROSS.

Driving Screws Around a Corner.

Editor American Machinest:

It may not be easy to make a gun that will shoot round a corner, but with a screw-driver it is a very easy matter, as you will see by enclosed sketch.

This was made for a special job where it was inconvenient to put the screw in in any different way. STERLING ELLIOTT.

NEWTON, Mass.

The Glass Ball Problem.

Editor American Machinist:

I guessed the glass ball was about 8″ in diameter, but was much surprised to find after working it out that the diameter was only a little over $1\frac{1}{16}''$.

By algebraic solution, 1.695″.

ANSONIA, Conn. J. J. F.

[NOTE.—Since receiving the above, Henry Dreses sends us from Cincinnati, O., his solution, worked out by algebra, making the outside diameter of shell 1.69509″. Samuel J. Wisdom, of the Florida Western Railroad shops, who says his first guess before working out the problem was $1\frac{3}{4}''$, gives 1.6952″ as his solution by arithmetical computation, but we would like from him particulars as to how he forms his equation. We do not think it necessary to publish the algebraic formulas by which these and previous results are obtained.

Tempering Picks.

Editor American Machinist:

An inquiry in the AMERICAN MACHINIST of November 28, calls for the best manner of tempering picks for use in mining.

If the steel is good, heat moderately hot, and do not hammer after the redness disappears. Harden as you would a chisel, and draw to a blue. The blacksmiths about the mines are often careless, and having two or three picks in the fire, some of them are heated too much. They generally hammer the picks when too cold, and the steel is injured thereby. I have been out in the mountains of Colorado, and have often paid the blacksmith for the use of his fire, fixed my own drills and picks, and have saved both time and money by so doing.

To be brief: Don't heat too hot or hammer too cold; harden and draw to a blue, as you would a chisel. J. H. M.

PAWTUCKET, R. I.

Machines for Testing Foundry Mixtures.

BY ROBERT E. MASTERS.

The AMERICAN MACHINIST, of December 6th, 1884, contains two articles on the importance of testing mixtures of cast iron in foundries.

David Spence, the author of one of these articles, writes: "I have tried a great many brands of iron for strength; the highest test that I ever obtained was by mixing No. 1 Ohio, American Scotch (Rockwood brand), No. 1 Lake Superior (Appleton brand), and good machinery scrap in equal parts. I have made test bars from this mixture 2' long, $1\frac{1}{4}$" square, and obtained as a result a test of 1,700 pounds."

Mr. Spence omitted to state how the tests were made, and what distance it was between supports. I lately wrote to him in regard to the matter, and he tells me that he made a mistake in giving the size of the bars as $1\frac{1}{4}$"; that they were $1\frac{1}{8}$" square, 30" long, and 24" between points of bearing. He also sent me a rough sketch of his testing machine, from which the drawings, Figs. 1 and 2, were made. I trust he will pardon the liberty I have taken in making some slight changes in, and additions to, this machine, which, I think, make it better adapted for the purpose for which it is designed.

A, in side elevation Fig. 1, and in plan, Fig. 2, is a wooden lever-beam fastened between the two uprights *B B*, and acting on the bolt *C;* on top of the lever-beam, a cast-iron track *D* is bolted. At the point of breakage a bolt with a conical head is put through the beam and end of the track. A washer is put between the bolt head and the beam, as seen at *E*. The cast-iron counterpoise weight *F* is adjusted to balance the beam, and is fastened with a set screw. The test bar *G* is then placed on the standards *H;* the weight *I*, which is attached to the sheave by two wrought iron arms, is then placed on the lever near the breaking point and run out gradually to obtain the transverse breaking pressure.

To those who may not understand the system of marking off a lever of this description, I will add: the quickest way to mark the figures on the beam is, after the beam has been balanced, let the point of the bolt *E* rest on the platform of a scale, and as the weight is rolled out the scale will indicate the pressure. Every inch, if desired, can be marked accurately.

The simplest machine for this purpose, which the writer has ever used, is shown in Fig. 3. The beam *J* is cast with a hub in the center, and after a thread has been cut in it for the screw *K*, the beam is bolted to two uprights. A good platform scale of one ton capacity, such as should be used in every foundry for weighing iron, is placed under this beam.

Scales of this capacity have a platform 30" long; this leaves plenty of room for the two blocks *L L*, which are 3" square, to be placed 24" apart; upon these blocks the bar to be tested is placed. The weight of blocks and test is noted, the screw then turned down with the lever *M*, the weights being added on the scale as the pressure demands it. After the bar has been broken, subtract the weight first obtained of the bar and blocks from the weight at which the bar broke, and the remainder will be the breaking pressure. To obtain the shrinkage of the iron, all that is necessary is to place the pattern and the test-bar casting side by side, square each other at one end, and the difference can be easily measured at the other end.

To obtain the deflection: After the screw has been brought down until the point touches the bar snug at *N*, measure from the top of the beam to the top of the screw, after the bar has been broken this can be measured again and the difference noted.

A very cheap arrangement can be made for testing bars by this plan; by boring a hole deep enough for the screw to work in, through any firm wooden beam, and fastening a large cast-iron washer with a thread cut in it, to the under part of the beam; the deflection could then be obtained close enough for all practical purposes, by placing a square on the scale, letting it come up against the bar at *N*, and holding it there while the screw is being forced down.

The shrinkage and strength of cast-iron mixtures are two very interesting and important subjects. I would suggest to those who make tests, and are willing to let the results be known, that we establish a standard, so that the transverse breaking load and shrinkage of the different mixtures can

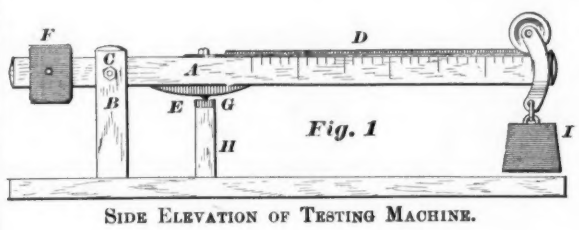


Fig. 1

SIDE ELEVATION OF TESTING MACHINE.

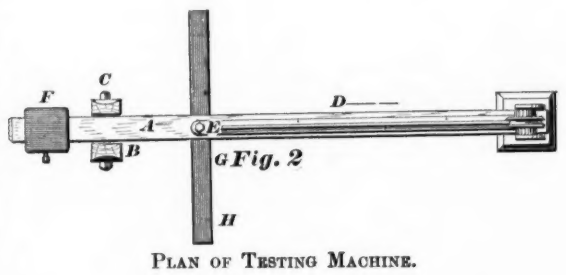


Fig. 2

PLAN OF TESTING MACHINE.

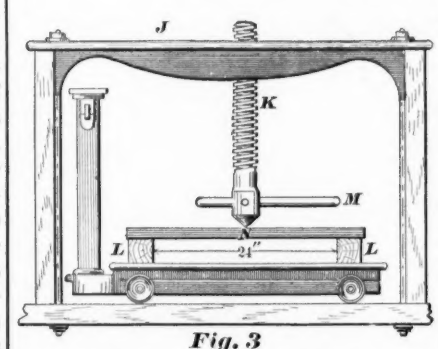


Fig. 3

SIMPLE TESTING MACHINE.

be more easily compared. For instance, patterns from which test bars are to be made to be exactly 3' long and 1" square; tests to be made 24" between supports, care ought to be taken in moulding these bars, so that they do not swell, and show a higher test than 1" square would give.

Any one making a report of tests made should be particular to mention the following points, besides these suggested: Exact mixture of metals; position in which moulds were poured, whether horizontal or on an incline; and whether the metal was very hot or dull.

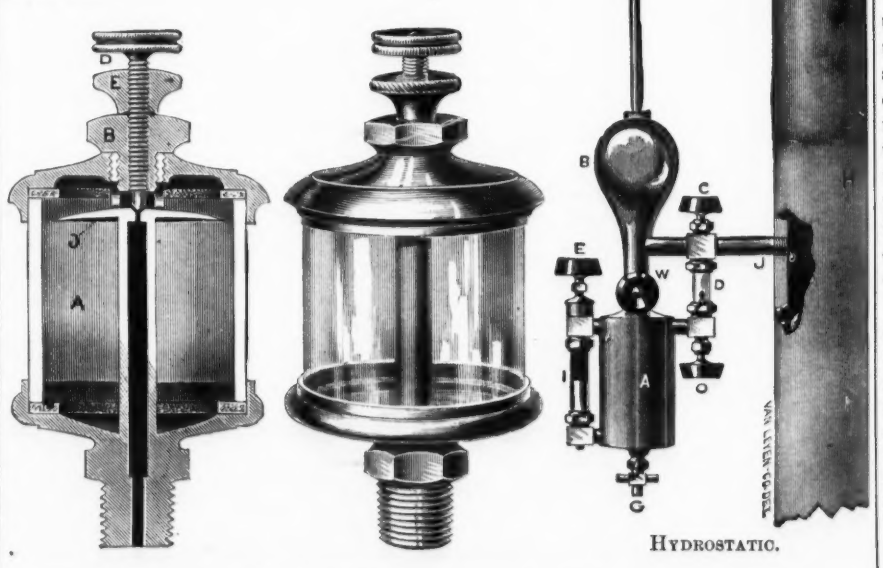
The left hand cuts show an automatic crank-pin oiler, which may be applied to either high or low speed engines. When attached to slow-running engines, the oil is continually flowing over the convex disc *c*, and a portion of this oil is discharged into the central tube, and runs to the parts to be lubricated. In quick running engines, the oil is lifted to the top of the cup, by centrifugal force, and the pressure of the oil is increased or diminished with the speed of the engine, causing the oil to cease flowing when the engine stops.

The report of a committee appointed by the French Academy to inquire into the superheated water theory of steam-boiler explosions has been published in *Annales des Mines*. The committee did their work very thoroughly. They constructed suitable apparatus, experimented in the most exhaustive manner with it, and investigated several explosions, claimed by the advocates of the theory to have been due to this cause. They failed utterly to superheat water under all conditions which could possibly occur in practice, and all the explosions investigated, were shown conclusively to have resulted from simple deterioration of the boilers, or from carelessness. Their refutation of the theory is most signal and complete.—*The Locomotive.*

Premium to Subscribers.

Generally we do not believe in the practice of certain publications which offer premiums as an inducement to subscribe. An exception, however, may be noted in the case of a "Grant Memorial" print, photo-lithographed from an original pen and ink design executed at the office of the *Penman's Art Journal*, which that paper proposes to give as a premium to each yearly subscriber.

The print will not only serve that purpose, but serves also to illustrate, in a pleasing way, the principles of penmanship.



HYDROSTATIC.

Improved Sight-feed Lubricators.

The engravings herewith given, illustrate a number of sight-feed lubricators manufactured by the Michigan Lubricator Company, Detroit, Mich. The right hand cut shows a "Hydrostatic" lubricator. The arms and condenser are cast in one piece, giving great strength, and avoiding the possibility of a leaky joint. The filler is large; a vent at the rim of filler permits of quick filling, and a large drain valve facilitates emptying the cup of condensed water. These remarks will also apply to the "Portable" lubricator, which is made by the same company, with the exception that the nut at the filler does not require a vent, as this cup has no gauge glass. When the "portable" is attached to threshing or portable engines, the body of the cup is cast with a jamb nut at the pet cock, which secures a very strong connection.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SIXTEENTH PAPER.

POWER REQUIRED TO WORK PLAIN SLIDE-VALVE, ROLLER VALVES AND BALANCED SLIDE-VALVES.

The great aim of engineers, in constructing a slide-valve for a locomotive, is to produce a valve that will require as little power as possible to work it. Consequently, when a plain slide-valve is to be used, such as we have shown in some of the foregoing papers, the valve face is made as small as it can be made, without interfering with the duties that the value has to perform.

Again, it is of very great importance to have the mechanism inside of a steam chest as simple as possible, therefore, on account of the great simplicity of the plain slide-valve, it is more extensively used than any other kind. Yet it has its drawbacks, besides requiring a considerable amount of force to move it forward and backward on its seat; for instance, it is liable to cut the valve seat, wear the link, rocker, pins and eccentrics comparatively fast, and when the valve is large, it is difficult to reverse the engine.

Let us for a moment consider the amount of force that will be required to move an ordinary plain slide-valve. The resistance which must be overcome in moving any slide-valve is simply the friction between the valve and its seat. This friction depends upon the pressure of the valve against the seat,* and this pressure is equal to the total steam pressure upon the back of the valve, minus the reaction of the steam pressure in the steam and exhaust ports.

This state of affairs we have endeavored to illustrate in Fig. 71, (page 7) in which the arrows marked 1 indicate the pressure of the steam on the back of the valve, and the arrows marked 2 indicate the reaction of the steam pressure in the ports.

To present, in a plain manner, the subject of finding the amount of this friction, let us take the following example: The valve is 9 inches long (see Fig. 71) and 16 inches wide; the steam pressure in steam-chest is 120 pounds, it is required to find the amount of force necessary to move the valve.

The total pressure on the back of the valve is found by multiplying the area of the valve face by the steam pressure, hence we have $9\times16=144$ inches, which is the area of the valve face, and $144\times120=17280$ pounds, which is the total pressure on the back of the valve, but is not the pressure of the valve against its seat.

To obtain the latter, we must deduct from the total pressure on the back of the valve, the reacting pressure in the ports. The reaction of the steam pressure in the ports can only be obtained approximately, because there are no data from which we can make the calculation. It will readily be seen that the reaction of the steam pressure in the ports, when the valve is in full gear, is affected by, and depends upon, the size of the exhaust nozzle, the speed of engine, the lap of valve and some other details.

This pressure is also variable during the travel of the valve. For our purpose here, we will take the average. From observation the writer is led to believe, that in ordinary locomotives the reacting pressure is equal to one-third of the pressure on the back of the valve. Grant that this is true, then the total pressure acting in the direction of the arrows 2 will be equal to

$$\frac{17280}{3}=5760 \text{ pounds.}$$

Subtracting this quotient from the total steam pressure on the back of the valve, we obtain the pressure of the valve against its seat, hence we have $17280-5760=11520$ pounds, which is the pressure of the valve against the seat.

In order that the reader may obtain a better idea of the effect of this pressure, we may say that this valve has to be moved forward

* The weight of the valve being comparatively small, it is left out of the question.

and backward with a load of 11520 pounds, (nearly six tons) upon its back.

The friction between two cast-iron surfaces which are straight, smooth and lubricated, generally ranges from $\frac{1}{16}$ to $\frac{1}{14}$ of the pressure. In this case we will adopt the former proportion. Therefore, the friction between the valve and seat is found by dividing the pressure on the valve seat by 10, hence

$$\frac{11520}{10} = 1152 \text{ pounds.}$$

This 1152 pounds is the friction, or we may say, the resistance which must be overcome, in moving the valve, therefore, a force of 1,152 pounds is required to move the valve on its seat in a direction as indicated by arrow 3, and the same amount of force is also required to move the valve in an opposite direction. To work such a valve as quickly as must be done in a locomotive will need a great amount of power; also, whatever power is used for this purpose is a loss, because the engine will have that amount less with which to perform useful work, that is, to haul the train.

It must also be plain to the reader, that a valve working under such a pressure is very liable to cut the valve seat, and the only way that this evil may be prevented to some extent, is to use the best of metal in the cylinders, and keep the valve well oiled. We have shown that this valve requires a considerable amount of force to move it on its seat, and since this force is transmitted through the eccentrics, links, rockers and pins, it follows that these will also wear very quickly. Again, to pull the reverse lever from one notch to another, on a locomotive having cylinders about 16 inches in diameter, is often laborious work for an engineer, and still more so in modern engines, because these generally have larger cylinders and consequently larger valves.

From the foregoing remarks we learn that although the plain slide-valve is extremely simple, and can and must be made to distribute the steam correctly, the steam pressure on the back of this valve impairs its usefulness; and consequently the desire which exists among engineers to procure a valve in which the evil effects of pressure on the back of the same, will be removed.

ROLLER VALVES. BALANCED VALVES.

There are in use two distinct kinds of valves which require less power to work than the plain slide-valve. One kind comprises the roller valves, and to the other kind belong the balanced valves, or as sometimes called, the equilibrium slide-valve.

Although less power is required to work the roller valve, than is needed for the plain slide-valve—and therefore, when a roller valve is used the wear of the valve gear will be reduced—this valve has never been, and is not now, very extensively used, and in the writer's opinion, this should not be a matter of surprise, because in the construction of these valves, no attempt has been made to remove the steam pressure on the back of the valve, which so impaired the usefulness of the plain slide-valve. But since the roller valve is sometimes adopted, the writer believes that a description of it will be interesting to the reader.

Figs. 72, 73 and 74 represent different views of the roller valve, and as will be seen, the only difference between the roller valve and the plain slide-valve, is that the former is constructed in such a manner as to make room for the rollers *r r r*, which are interposed between the steam-chest seat and the valve. These rollers are prevented from touching each other by the small axles *x x x*, and around these the rollers turn. These axles, with the rollers placed upon them, are riveted to the bars *t t*, so that, when this arrangement is completed, as shown in Fig. 74, a small carriage is obtained on which the valve is to work. To prevent wear of the steam-chest seat and valve as much as possible, steel plates *p p*, Figs. 72 and 73, are laid on the steam-chest seat, but not fastened. Two other plates *u u* are attached to the valve, and between these plates the carriages are made to roll. The most important dimensions are given in the figures, and the general arrangement is also plainly shown, so that a further description is unnecessary.

A balanced slide-valve is represented in Figs. 75, 76, and 77. This valve is extensively used in modern locomotives, and seems to be growing in favor. In the construction of these valves the correct principle has been followed, namely, the removal of the steam pressure on the back of the valve. This is accomplished by cutting grooves around the back of the valve, and

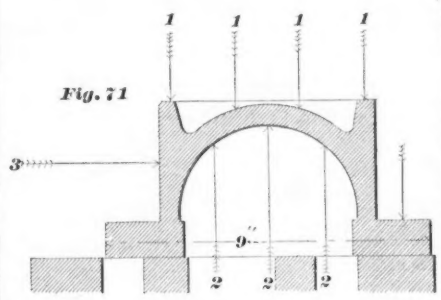


Fig. 71

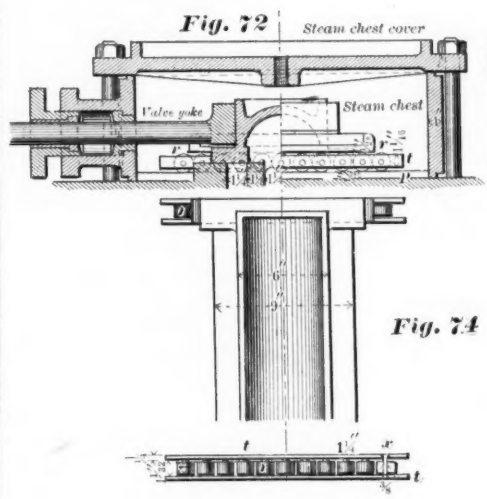


Fig. 72

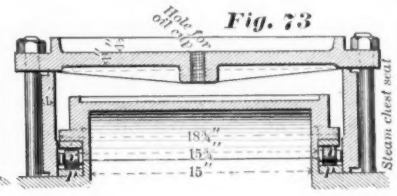


Fig. 73

Fig. 74

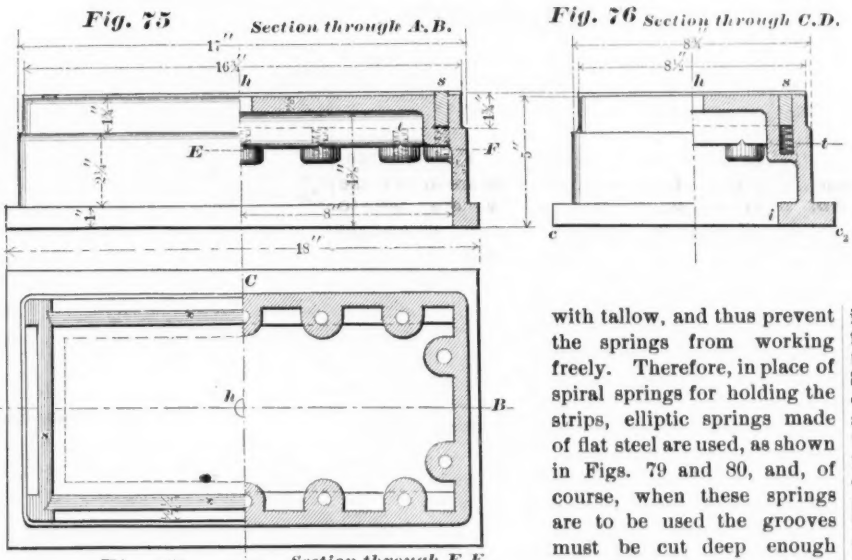


Fig. 75

Fig. 76

Fig. 77

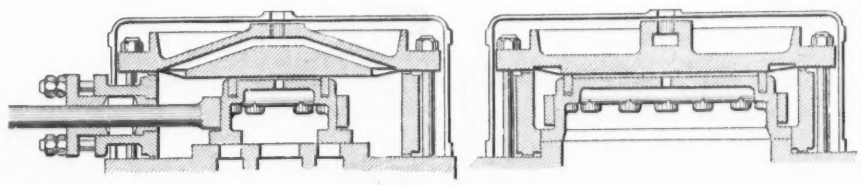


Fig. 78

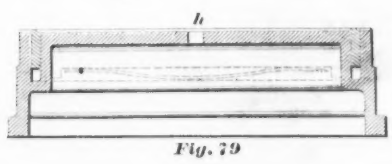


Fig. 79

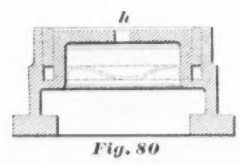


Fig. 80

width of the strips. The manner of joining them at the corners is plainly shown in the plan of the valve, Fig. 77. For the sake of distinctness the strips have been shaded in this figure.

Some master mechanics object to the spiral springs, because the pockets in which these springs are placed will, in time, fill up with tallow, and thus prevent the springs from working freely. Therefore, in place of spiral springs for holding the strips, elliptic springs made of flat steel are used, as shown in Figs. 79 and 80, and, of course, when these springs are to be used the grooves must be cut deep enough to receive them, and the care must be taken to cut these grooves perfectly true; in these, strips *s s s* of cast iron are accurately fitted, so that the latter may move up and down in these grooves without any perceptible play. The strips are held up by spiral springs *t t t* as shown. Some mechanics make these springs of hard brass wire, while others prefer to use steel wire for the same.

The diameter of the wire used ranges from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch. The number of springs generally employed is shown in the pockets, as shown in Figs. 75 and 76, left out.

Yet these elliptic springs are not free from objections. Some master mechanics disapprove of them because they are too strong when new, and consequently are liable to cut the steam chest cover.

On the other hand, if these elliptic springs are made weaker, so that they will work satisfactorily in the beginning, they will not remain so long, but become too weak to hold up the strips. The result of this disagreement, among master mechanics, is that there are about as many valves with spiral springs in use as there are with elliptical springs.

All balanced valves of this kind should have a hole *h*, about $\frac{3}{4}$ of an inch in diameter, through the top of the valve; without this hole the valve will lift off its seat. When a locomotive is running and then steam shut off, a partial vacuum will be formed in the steam chest, causing the valve to chatter, and thus ruin its mechanism. To prevent the forming of a vacuum in the steam chest, and consequently its evil effects, a vacuum valve must be attached to the steam chest to admit air into the latter when steam is shut off during the time the engine is in motion. Without this vacuum valve no balanced slide-valve must be expected to work successfully. Indeed, it is good practice to attach a vacuum valve to all steam-chests in which a plain slide-valve is working, as this will often be the means of preventing the ashes from being drawn into the cylinder and the steam-chest.

When these balanced valves are properly made by *mechanics*, not cheap labor, good results can certainly be looked for. We find it recorded in the annual report of the "American Railway Master Mechanics' Association," for the year 1884, that a passenger locomotive with 16"x22" cylinders, and driving wheels 5½ feet in diameter, and a Morse balanced valve, ran 166,000 miles without any need of facing the valve seat.

Another good result obtained by using the balanced valves, is that the reverse lever can easily be handled, something to be appreciated by the engineer having charge of the engine. The balanced valve, which of late seems to be the favorite, is such as we have shown in the figures, and is called the "Richardson" balanced slide-valve. But by this remark the writer does not wish to be understood that this is the only good balanced valve, he simply wishes to state facts as they appear to him.

Liquid Fuel.

Iron (London) devotes considerable space in its latest issue to the question of liquid fuel, instancing the steamship Himalaya. It says:

"This vessel is a trader of 100 horse-power, nominal, and 800 tons burden. She is 210 feet long, with 28 feet beam, and is fitted with compound engines, driving a screw propeller. The boilers have three furnaces, each of which has an openwork fire-brick lining on the principle of the Siemens regenerative system. At the end of each furnace is a fire-brick baffle having an aperture through which the heat passes to the tubes from the furnace, or, as it may more correctly be called, the combustion chamber. In this chamber is a coil of iron pipe, one end of which is connected with the steam space of the boiler, and the other opens out at the door of the chamber. This coil is for the purpose of superheating steam taken from the boiler, and by which an induced current is set up, which carries the petroleum forward into the combustion chamber. In order to enable it to do this, the petroleum nozzle is placed within the steam pipe at the opening where it delivers its jet, so that an annular space is formed through which the steam rushes, and, combining with the small but regular flow of the oil, produces a large volume of flame within the chamber. The oil is stored in tanks on the main deck, whence it flows by gravity to the delivery nozzles at the furnaces. The whole apparatus is very simple and easily adjustable. * * *

"We recently inspected the furnaces and oil equipment of the Himalaya while in dock, and witnessed a demonstration of the satisfactory working of the apparatus; combustion being nearly perfect, as evidenced by the very small amount of smoke that issued from the funnel. A fairly steady steam pressure of 55 pounds per square inch was maintained, the steam, of course, being blown off as made.

"Taking the circumstances of the case generally, including the attempt now being made by Russian enterprise to secure a regular and full supply of oil to this country, it would appear as though the solution of the liquid fuel problem was at hand. That solution would mean an enormous saving in our solid fuel, coal, whilst our steamships would be relieved of some 50 per cent. of their fuel weight, which could either be assigned to cargo, or, where long voyages had to be made, to a double supply of liquid fuel."

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NEW YORK, DECEMBER 26, 1885.

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Railroading on the Brooklyn Bridge.

The railway service on the Brooklyn Bridge has again failed to answer the requirements of well arranged and well managed service, and this time the failure has resulted in seriously maiming several passengers. As usual in the numerous instances of failure, the trouble is said to be with the grip. There is some conflict in the accounts of the catastrophe that are obtainable, but briefly stated, it appears that the track was damp, and that trains were following each other at intervals of one minute and a half. Two trains were on their way up the incline from Brooklyn, and another one just starting. At this time the grip on the foremost train failed to hold, and the train, instead of being stopped by the brakes, started back down the grade. Observing this the trainmen on the second train released the grip, and this train started back, the end being that it crashed into the third train, and was in turn struck by the first train. The primary cause of the accident was the failure of the grip, and the secondary cause, a failure of the brakes to hold either train, through inefficiency, or through not being properly operated.

During almost the entire time this road has been in operation, it has been plain to the public—such part of it as has given the matter any consideration—and ought to have been to the management, that the grip was liable to fail at any minute; its failures have been so numerous as to be taken as a matter of course, and generally to pass without other comment than that furnished by the witty paragraphers of the daily press. It ought to have been just as apparent that a failure was likely to occur any day under circumstances that would result in loss of life. Perhaps this view of the case was not taken by the management, but it certainly would have been by men experienced in railroad operating. The frequent shortcomings of the present grip have given sufficient warning of what might be expected from its use. At last, not so soon as seemed probable, it has furnished material for tragic comment.

It is said there is no grip that will answer the requirements of the bridge service; that other grips that have been proposed will destroy the cable, etc. This is disputed. Whether it is true or not, can be settled by trial. The operation of the railway ought to be stopped entirely, until the question of the grip is definitely settled; then, if found that the present grip is the best that has been or can be devised, resumption of operations should not be permitted, until other means of propulsion are adopted. The authorities have a plain duty to perform, in seeing that something is done to protect the lives of passengers on the bridge.

But aside from the grip, if there is not skill enough connected with the bridge management to use means for stopping trains on the grade, when the grip or any other means of propulsion fails, then the present officials ought to resign, in favor of those who know more about railroading. If the road is to be operated in the future as it has been in the past, the public will do well to take to heart the reported remark of one of the officials, to the effect that, under the same circumstances, a similar accident was likely to occur at any time.

The bridge itself is a great engineering work. It is a pity that something favorable cannot be said of railroading on the bridge. Sending out on a grade, at a minute and a half headway, passenger trains which cannot be held by the brakes, and on which it is known by continued experience, that the propelling power is about as likely as not to fail, is too careless a proceeding to be seriously called railroading!

On another page we publish a communication upon this subject from Charles T. Porter, a mechanical engineer whose ability and standing will be disputed by no one. Mr. Porter's article is written at our request, made from our knowledge of exceptional opportunities which he has had for becoming acquainted with the subject.

We ask special attention to the points made by Mr. Porter, which disprove the current statements attributing the recent disasters to insufficient terminal facilities on the New York side. The true explanation is, that it is the mechanical, not the terminal "facilities," which are inadequate.

As a practical step toward the solution of the problem, we call upon the Trustees of the Bridge, in whose hands the lives of thousands are daily placed, to institute a searching investigation of this subject at the hands of a properly selected Board of Mechanical and Railway Engineers, such as will command the confidence of the public.

Close of Our Eighth Yearly Volume.

With this issue Volume VIII. closes, and, in accordance with our annual custom, we send out with this week's paper a carefully-prepared index to the articles which have appeared in our reading columns during the past year. The index is divided, as heretofore, into three parts, viz., general topics, "Letters from Practical Men," and "Questions and Answers," the distinctive features of each department having been fully sustained during the year, as the index shows.

Our new volume will have a new dress of type, which, though not cut from exactly the same piece as the old, is "like unto it," with the advantage, as we hope, of added clearness.

We receive so many substantial evidences that our readers are satisfied with the record, as to performance, which the AMERICAN MACHINIST has made during the year just closing, that no words of special "promise" for the ensuing year will be required by those familiar with its pages.

Beginning the new year with the largest legitimate circulation of a mechanical or engineering kind in the world, no innovations are proposed in the general plan, whose correctness has been increasingly demonstrated by the experience of eight years. There is every indication that the AMERICAN MACHINIST will continue to be the channel through which the greatest number of practical mechanical writers ever attracted by any journal will place the results of their experience and observation before the greatest number of readers. The very multiplicity of technical and trade journals which have arisen during the past few years, with the consequent impossibility of reading all of them, felt by busy men occupying responsible positions, tends steadily to increase the circulation of leading journals.

The close of the year finds the machinery trades in a much more favorable position than was the case one year ago, the better employment of mechanics, in most lines of business, at improving rates of wages, forming not the least important factor in the improved situation. Prospects for the future, too, have grown brighter, and, if the present cheerful outlook continues to be justified by the course of events, the result will be well deserved by the establishments and employes that have stood the test of the three years of depression, now, let us hope, substantially at an end.

An Important Point in Selling Machinery.

Said a builder of steam boilers recently, glancing, as he spoke, at a fireproof safe and a platform weighing scale, which stood near: "Why didn't I get into some kind of goods that are easy to sell, like safes or scales?" He spoke under the influence of one of those moods that come at times to many a perplexed manufacturer.

The reply which his remark elicited was to this purport: "But in that case your salesmen would have to convince prospective purchasers, single-handed and alone, of the merits of your wares; they would find that a difficult task, unless you happened to possess the advantage of an extended reputation. In introducing your wares you would not be likely to enlist the powerful aid of the great body of mechanics throughout the country, as you now may through their familiar knowledge of what you make."

The rejoinder above quoted emphasizes the wisdom of those successful machinery establishments who count no pains too great which go to make the construction and operation of their machinery known to thinking mechanics all over the country. Indirect though it may often be, such establishments realize how potent the influence of these mechanics is in introducing improved machinery into thousands of establishments, where its advantages might otherwise be long overlooked.

A leading builder of steam dredging machinery once said he wanted no better friends, in his business, than the men, working at so much a day, who run the engines on the dredges used in this and other countries.

Another case in point is the remark of one of the heads of a large machinery building establishment, that he knew of $70,000 worth of their machinery which, up to date, had been sold through the more or less effective recommendation of one man, now a machine shop proprietor, who has risen to that position after being, successively, apprentice, workman and foreman.

Had the establishment referred to any adequate means of estimating the amount of machinery, for the sale of which they stand indebted, in greater or less degree, to the mechanics whose names they do not know, the total might reach figures that would be, to say the least, noteworthy.

Making and Using Cast Iron Test Pieces.

The suggestion made in another column by Mr. Masters, in regard to making and using test pieces from different mixtures of cast iron, is a good one. It should be acted upon by foundrymen in general. There is too much hap-hazard work done in this matter. At present many foundrymen guess that the mixture is "about right," and let it go for good or for bad; whereas, had test bars been made and used, they would know exactly the value of their iron, and all guess work would be eliminated.

George F. Ballou writes us from Waltham, Mass., stating that his connection with the Ballou Manufacturing Company, of Hartford, Conn., has ceased.

The copy from which J. G. A. Meyer's articles on "Modern Locomotive Construction" are put in type for our columns, is a blue print from the manuscript as written. This method of duplicating manuscript may be of value to other correspondents.

The department of "Letters from Practical Men," in our issue of December 19, contained a communication from Joseph White, of Lima, Ohio, describing a "Good Arrangement for Furnace Grates." By an error, it was there said, that the diameter of the grate should be 1½" less than the diameter of the furnace. It should be only ½" less.

The Universal Postal Union.

According to the annual report of Postmaster-General Vilas, the Kingdom of Siam joined the Universal Postal Union on July 1. On January 1 next, the Congo State becomes a member, while, beginning April 1, 1886, the AMERICAN MACHINIST can be mailed to Bolivia, at the regular rate for foreign subscriptions, instead of at an extra cost of $1.00 a year, as at present. The area of the Universal Postal Union has therefore been so far enlarged as fairly to justify its name. We believe some parts of South Africa still remain outside.

While the Postmaster-General is about it, however, he would greatly serve the convenience, at least, of American newspapers having a world-wide circulation and receiving money orders from all parts of the world, if he would prevail upon foreign governments to adopt for their money-order system the method in use in this country. We are continually receiving notice from the New York post-office, that a German or

Swiss, or Italian money order is in hand to our credit, but duplicate blanks not being filled out abroad and given to persons purchasing money orders, we are frequently at a loss to know whom the money comes from, causing confusion and delay in entering up the subscription.

Do not trust a gauge cock, or a water-line glass, without testing them every day to make sure they are not clogged up.

An Algebraic Exception.

Our readers know that algebra and the higher mathematics are admitted to our reading columns only under exceptional circumstances. Such an exception occurs in this issue. As stated in the article itself, Mr. Grant's paper on "Efficiency of Gear Teeth" employs the algebraic as well as the graphical process, for the reason that the results worked out "are so close that no graphical or experimental process can possibly show their real difference, and our only reliance for that purpose is on analysis."

Making Engravings of Machinery and Tools.

In our last issue we noted some points relating to the preparation of machinery circulars and catalogues. The quality of the engravings used contributes so largely to the value of the completed catalogue or circular, that a few suggestions as to the preparation of such engravings, may not be out of place. We are further led to notice this subject, because of the numerous inquiries we receive, asking for information regarding it.

In showing up a machine or tool in catalogue or circular form, there are usually two objects worth attaining. One is to give mechanics an idea how the completed machine looks, and this can be best done by means of a good wood-cut, showing it in perspective, and making it appear, not as a mechanical conception merely, but as a finished machine, actually ready for the market.

The other is, to show details connected with the machine, wherever required, in such shape as to make the construction and operation of the machine clear to the mechanics who are expected to buy it, to recommend it, or to use it. This may, in some cases, be best done by the preparation of wood-cuts, showing the parts in perspective. Generally, however, such details are well shown by the use of "wax-cuts," by which term is meant, outline engravings, cut in a block of wax, instead of wood, by the use of hand tools.

Wood-cuts may be engraved by the wood-engraver from drawings sketched directly upon the wooden block by a skillful artist, working either from observation of the machine itself, or from drawings or photographs representing it. Where very excellent work is desired, this is often the better way, but a skillful artist is of course necessary.

Or, a photograph of the machine may be re-photographed direct upon the wooden block, and to any size desired, there to be cut out in perspective by the wood-engraver. In making two or more wood-cuts alike, except as to size, some expense is usually saved by including all in one order.

Wood engravers, so called, differ greatly as to skill and quality of work turned out. Light and shade, distinctness, correctness, are all essential to a good wood-cut. In a wood-cut the lines should not be too fine; otherwise it will not print well.

After a wood-cut is once made, as many electrotypes as are desired can be struck off from it at small expense. Printing should never be done from the wood-cut. It is desirable, whenever practicable, to make electrotypes from the original wood-cut, rather than from other electrotypes, as the resulting impression will be clearer.

"Wax" cuts may be "engraved," so to speak, direct from the drawing, if correctly done and of the size required. If a different size is wanted, a photograph of the required size should be made from the drawing, for the use of the wax engraver. Duplicates can be readily electrotyped from wax-cuts at pleasure. Generally wax-cuts are considerably less expensive than wood-cuts.

For commercial purposes, wax-cuts, while their lines are sharp, and they print well, are mainly valuable for auxiliary use in connection with wood-cuts, to show up diagrams, sectional views, etc. For such purposes, they are not well adapted to be used alone.

There remains only one word of caution to be added. Do not accept a poor wood-cut, because it costs a little less. Do not attempt to show machinery by using "photo engravings," or process work of any kind depending upon chemical means for forming the lines desired in the cut. Such lines, according to our experience, will be indistinct, coarse, and make the cut seem poor, at best. Cuts containing lines so formed, if their use is attempted by journals printing large editions, are certain to degenerate, after a few thousand copies have been printed, into smeared-up caricatures, creditable neither to the journals using them, nor to the machines they pretend to represent.

According to *Invention* (London, Eng.), a contrivance for steering screw vessels without a rudder has been patented by J. Waddington, and is simply a cylinder in which the propeller works, and is open at the end. The cylinder is worked in the usual way on deck. In a trial, 24 per cent. improvement in the speed of the vessel was obtained. It also enables a vessel to turn quickly in very little space while going at full speed.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials, nor location will be published.

(355) J. W. S., Philadelphia, Pa., asks how to produce the blue-black bronzing as seen upon the barrels and other parts of fine rifles? *A.*—A process described in the AMERICAN MACHINIST of August 15, 1885, (243) may answer the purpose.

(356) H. F., Taunton, Mass., asks who invented the screw propeller and the steam fire-engine—was it not John Ericsson? *A.*—It is not known with certainty who the original inventors were. The use of the screw propeller was proposed more than 200 years ago. John Braithwaite, of England, constructed a steam fire-engine in 1828 or 1829, which is believed to have been the first one having any practical value. Captain Ericsson had more to do with bringing the screw propeller into general use than any other single individual. He was also one of the early successful workers on the steam fire-engine.

(357) J. W. H., Baltimore, Md., writes: 1. I am designing a small horizontal engine—cylinder, 2" x 4"—common slide-valve, to cut off at ⅞ of the stroke. What should be the size of steam and exhaust ports; also size and throw of valve? *A.*—You will get good results with steam-ports 3-16" x 1½": exhaust-port, ⅜" x 1½", outside lap of valve, 1-10"; inside lap, 1-32"; travel of valve ⅝". 2. Will ¼" steam and ⅜" exhaust pipe be large enough? *A.*—Better make the steam-pipe ½" and the exhaust pipe not less than ⅝". The above is on the supposition that you will run at a speed of from 400 to 600 revolutions.

(358) T. G. L., Eureka, Cal., asks: What is the best method of brazing copper thimbles on iron tubes, as practised on locomotive work? *A.*—We referred the above question to J. G. A. Meyer, who replies as follows: The usual practice in locomotive shops is not to braze the copper thimbles to the iron flues; they are simply laid on loose, then allowing both the flue and thimble to project ¼" beyond the flue sheet, both are expanded and rolled over. When we receive orders for locomotives in which the thimbles are to be brazed on the flues (which rarely happens), we order the thimbles to be brazed on the flues in the works in which the latter are made. The method we adopt for the small amount of brazing copper thimbles to iron flues or pipes we have to do, is as follows: The end of the pipe to which the thimble is to be brazed is thoroughly cleaned by filing or dipping in acid; then the thimble is placed in the correct position on the flue and both are heated over a fire; when hot, spelter is allowed to run between the flue and thimble.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

T. M. Parker, Steel Stamps, Stencils, Hart'f'd, Ct.

J. Clayton, Air Compressors, Rock Drills. 43 Dey st, N Y

Edw. Sears, wood engraver, 48 Beekman st., N.Y.

Steel Name Stamps, &c. J. B. Roney, Lynn, Mass.

Tack, Wire, and Shoe Nail Machinery; Wm. A. Sweetser, Brockton, Mass.

Steel shank, wire nail, shoe nail and tack machinery. Keith & Trufant, Campello, Mass.

Tack and Wire Nail Machinery, made by the Willets Mfg. Co., Providence, R. I.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Patent attorney and expert. Machine designs and details. Wm. H. Weightman, 82 Astor House, N.Y.

Foot-Power Machinery for workshop use, sent on trial if desired. W. F. & Jno. Barnes, Rockford, Ill.

Lyman's Gear Chart. How to lay out gear teeth Price, 50c. E. Lyman, C. E., New Haven, Conn.

Drop presses, and other special tools, manufactured by Williams, White & Co., Moline, Ill.

Improved Labor-Saving Upright Drills. 20 in. to 36 in. inclusive. Currier & Snyder, Worcester, Mass.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 86 John st., N. Y.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 62 Chatham st., N. Y.

E. Merritt & Co, Brockton, Mass., established 1859, only manufacturers of a complete line of Tack and Nail Machinery. Send for circulars.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Files recut without drawing temper, about one-half usual prices; samples recut free; prices on application. The Acme Co, Collinsville, Conn.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See Dec. 5, p. 13. Send for circular No. 17, Curtis Reg. Co., Boston, Mass.

"Complete Practical Machinist," $2.50; "Mechanical Drawing Self-Taught;" $4. Books for workmen. Joshua Rose, Box 3306, New York City.

Screw oiler, for chairs or stools; pat. June 16, '85; will sell Western, Southern, and Pacific States; address L. Postawka & Co, Cambridgeport, Mass.

Kellam's Pressure Regulator—used in heating system of 11-story building, Madison ave., N. Y.,—saved, last season, $2,000 over previous season. Hine & Robertson, 12 Cortlandt street, New York.

Locomotive Engine Running and Management. By Angus Sinclair. Gives full directions about handling and repairing locomotives; instructs how to design valve gear and set valves; Westinghouse air brake explained by aid of engravings. Price, $2. For sale by *National Car Builder*, 187 Dearborn st., Chicago, Ill.

Every young man who aspires to be either a mechanic, merchant, or manufacturer, owes it to himself that he become thoroughly familiar with the writings of Chordal. John Wiley & Sons, 15 Astor Place, N. Y., have issued a new and enlarged 12 mo edition of "Extracts from Chordal's Letters." Handsomely bound in cloth, with over 50 illustrations. Price, $2. Discount of 25 per cent on orders for five or more copies.

MANUFACTURES

Ground has been broken for a co-operative nail mill at Belleville, Pa.

James Phillips, Jr., West Fitchburg, Mass., has adopted weekly payments in his factory.

The Birmingham Rolling Mills, Birmingham, Ala., will soon add twenty puddling furnaces.

The Texas and St. Louis Railway will remove its shops and round-house from Tyler to Corsicana, Texas.

Notices have been posted in the Star Worsted Mills, Fitchburg, Mass., that payments will hereafter be made weekly.

The Chattanooga Chair Company, Chattanooga Tenn., have doubled their capital stock and will add new machinery.

J. D. McNeely, Salisbury, N. C., is organizing a stock company to build a cotton mill at that place. $35,000 have thus far been subscribed.

George McKim's factory for the manufacture of self-feeding nail machines, at Martin's Ferry, Ohio, will be ready for operation by December 15.

The Sutton lumber mill at Stillwater, Me., recently destroyed by fire, is being rebuilt by the former owners, A. B. Sutton and W. B. Hayford.

Frost & Adams, 37 Cornhill, Boston, Mass., have issued a new catalogue of artists' materials and mathematical instruments, containing about 160 pages.

J. W. Parker, of Grand Rapids, Mich., and Silas Dutton, of Alpine, have commenced to build a first-class saw and grist-mill at Alpine Station, Mich.

The furniture factory of Weakley & Warren, Nashville, Tenn., that was recently destroyed by fire in this city, will shortly be rebuilt on the old site.—*Artisan.*

Citizens of Uniontown, Pa., have raised money to begin the erection of a large steel mill; work will begin on the buildings in a few days. A new wire mill is also among the possibilities.

Mr. A. Rockenhousen, owner of the Pittsburgh Coal Works, below Bellaire, Pa., offers to subscribe property valued at $35,000 toward the erection of another nail works at that place.

C. A. Price is erecting a planing mill and sash factory on the corner of Fifth avenue and Twenty-third street, Altoona, Pa., which will be in running order by the 1st of January.

The stock for the new nail mill at Belleville, Ill., has all been subscribed. J. M. Hay, Richard Chew and Capt Wm. White are very active in the matter. It is to be run on the co-operative plan.

The Cartwright Iron and Steel Company, Steubenville, Ohio, which has a capital stock of $50,000, is just beginning operations, having bought a plant at Allikanna, a suburb of Steubenville.

The St. John Plow Company, lately organized at Kalamazoo, Mich., has a capital of $100,000, of which $20,000 has been paid in. Plows will be manufactured on contract until next season, when a factory will probably be erected.

At the late village election at Hesperia, Mich., to bond the village for $1,000 to put in a system of water-works, the citizens voted "yes" by a good majority. If the weather continues favorable, a portion of the work will be done before winter sets in.

The North Star Manufacturing Company, Springfield, Mass., organized for the manufacture of paper boxes and paper wares, has been incorporated, with John E. Stannard as president and Matthew C. Fenton as treasurer. The capital stock is $10,000.—*Paper Trade Journal.*

An order for 850 tons of steel was received on the 20th inst. at Carnegie's Union Steel and Iron Works, Thirty-third street, Pittsburgh, Pa. The order relates to the eight-inch mill only, and is considered unusually large. It will keep the mill in continuous operation for several months.

Goodnow & Wightman, 176 Washington street Boston, have just issued an illustrated pamphlet containing discription of a great variety of small tools for sale by them, including tools for machinists, pattern-makers, carvers, model-makers, jewelers and others. Castings for toy steam-engines are also included.

The Armington & Sims Engine Company, of Providence, R. I., have issued a fourth edition of the tasteful and striking pamphlet-catalogue of their engines, entitled "Power." A number of useful tables are given, together with data regarding the use of engines and dynamos in electric lighting.

The Gardiner (Me.) *Reporter* learns that very satisfactory progress is being made in regard to the woolen mill project. At a recent meeting held in that city, a committee, consisting of Weston Lewis, Charles Swift and A. C. Stilphen, was appointed to ascertain the price of the property, and to solicit subscriptions to the stock of the new company.

The Westinghouse Machine Company, Pittsburgh, Pa., are enlarging. They are building a furnace to be fired with natural gas, and are erecting a steam-hammer for the die forging of their connecting-rods from mild steel. They are also building a brass foundry for the production of their own castings. Natural gas has been introduced throughout the works.

The manufacturers at Livermore Falls, Me., have improved the water-power and business capacity of their mills, says the Lewiston *Journal*, which thinks that next year Livermore Falls will boom. The Umbagog Pulp Company will soon start their wheels again, having about finished an extensive and costly work in the shape of bulkheads and gates.

Knowlton Bros., machinists, Saccarappa, Me., have lately furnished paper mills with three driving pulleys, each measuring 7½ feet in diameter with 25-inch face, the three weighing 6,700 pounds. This firm have recently invented batting machines for the New England Batting Company, by which the rolls are turned out at a rapid rate and put in compact and convenient shape.

Foster & Brown, Saccarappa, Me., are driven with work in filling orders for machinery used in manufacturing wood-pulp pails by parties in Oswego, N. Y. The Westbrook *Chronicle* says that this firm have up to the present time had the exclusive manufacture of this class of machinery, and have filled large orders from Watertown, N. Y., and Great Falls, Me.

The Beloit (Wis.) *Free Press* gives a glowing account of the effective test to which an "Eclipse" fire extinguisher, in the hands of C. W. Caryl, of that city, was recently put in Beloit. Two blazing piles of highly-combustible materials, that hundreds of gallons of water would not have extinguished, were quenched by a single charge of the chemicals employed, being less than four gallons.

About a month ago the directors of the Williams Slate Quarry at Brownville, Me., decided to enlarge their quarry. The company have put in a new derrick and a new 20 horse-power portable hoisting engine and boiler. Thirty-five men are now employed, and it is the intention to nearly double this force in the spring. A new slate-cutting shed has been erected and new steam slate-cutting and boring machines introduced.

The furnace of the Leesport Iron Company, at Leesport, Berks County, Pa., which has been idle for the past ten months, resumed on the 1st, giving employment to a large number of hands. Several other furnaces in that locality are preparing to go into operation.

Not long ago there appeared the following in a Philadelphia paper: "It is reported that the Tyrone Mining Company of Pennsylvania has leased an ron mine in the town of Cumberland, R. I., and that smelting furnaces will be put up and operations begun next spring." Part of this statement was found, upon investigation, to be true and part incorrect. A charter was granted to the Rhode Island Iron and Steel Company, with a capital of $500,000, in 1864, to mine and work the ore taken from the Cumberland Hills, and the company was organized. In 1875 the mine and works were leased to a Mr. Miles Standish. Mr. Standish has been experimenting, and claims to have discovered a cheap method of working the iron ore, but, as to the certainty of beginning to work the mine next spring, it is possible, but not probable. The present officers of the company are: President, James H Chace; secretary and treasurer, Arthur H. Watson.

Machinists' Supplies and Iron.

NEW YORK, Dec. 9, 1885.

Consumers are ready to contract for next year's deliveries, but nothing definite has as yet transpired respecting such deliveries.

The market has ruled quiet, but firm, during the past few days, and the transactions have been of moderate proportions.

Iron—In American pig, the prices have, as a rule, been steady, with the exception of a sharp advance in Bessemer irons and old iron rails, which has stiffened the market for ordinary mill irons.

We quote Standard Lehigh and North River brands, $18 to $18.50 for No. 1 X Foundry; $16 to $17 for No. 2 at tidewater, and $14.50 to $15.50 for Gray Forge at furnace.

Scotch Pig—The market has not changed during the past week. We quote Coltness, $19 50 to $20; Glengarnock, $18.50 to $19 to arrive; Gartsherrie, $19 to $19.50; Summerlee, $19 to $19.50; Eglinton, $17.50 to $18; Langloan, $19.50, and Dalmellington, $18.25.

Lead—The market has been quiet and firm. Spot supplies have advanced to $4.75. There has been no change in manufacturers' prices

Copper—No changes are remarked; supplies have been firmly held. Lake, 11¼c.

Tin—Jobbing lots of Banca, 21½c.; Straits and Malacca, 20.95c cash.

Spelter—Domestic, 4 35c. to 4.60c.

Antimony—Hallett's 8 45c.; Cookson's, 9.45c.

WANTED

"Situation and Help" Advertisements, 30 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Situation as foreman of machine shop; good references given. Address Buckeye, AM. MACHINIST.

Situation as foreman or supt. of machine shop; good references. Address R., AM. MACHINIST.

Wanted—Foremanship of foundry; experienced in mining, milling, engine and railroad work; references. Address, Energy, AM. MACHINIST.

Wanted—Position as foreman of iron foundry, by a man of eighteen years' experience in bench and light floor-work in general jobbing; best of reference. Address, Bench, care AM. MACHINIST.

Wanted—Situation by designer and draftsman: has superintended several large works, and patented many valuable designs. Address, Practical Mechanic, AM. MACHINIST.

Wanted—Situation as foreman of machine shop; capable of managing one hundred and fifty men; all kinds of work; best of reference given as such Address, W., AM. MACHINIST.

Wanted—A practical springmaker, with experience in the manufacture of light and heavy spiral springs, of great accuracy. Address, with reference, stating qualifications and wages wanted, Spiral Springs, AM. MACHINIST.

Wanted—By practical mechanic, designer and draftsman, position as supt. or foreman of machine works; have had large experience handling men and systematizing work; best reference given; corresp'ce solicited. Address Box 486, Waterbury, Ct.

Wanted—A first-class brass finisher; one who has also some experience as machinist; must be a live man and competent to take charge of a shop doing all kinds of brass and iron work, especially jobbing and light machinery, in a city near New York; must speak German and English. Address J. E.—AM. MACHINIST.

MISCELLANEOUS WANTS

Advertisements will be inserted under this head at 25 cents per line, each insertion.

The Crescent Steel Tube Scraper is king. Crescent Mfg. Co. Cleveland, Ohio.

Comb-Grailing Machine wanted by Zylonite Comb and Brush Co., Adams, Mass.

Light mach'y of all kinds built at short notice. Pennington & Mills, 8 Dey st., Jersey City Heights, N. J.

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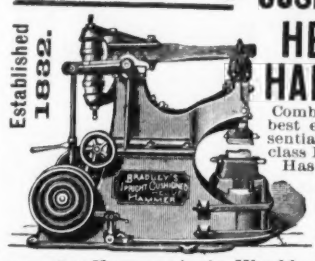
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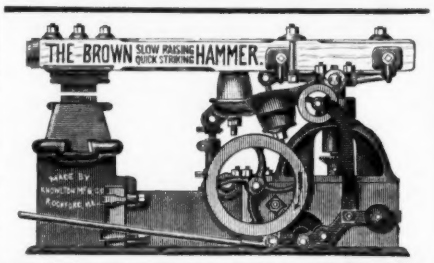

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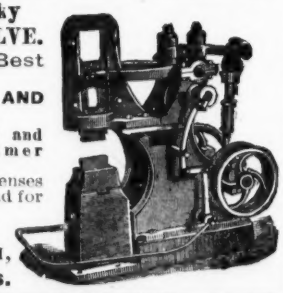

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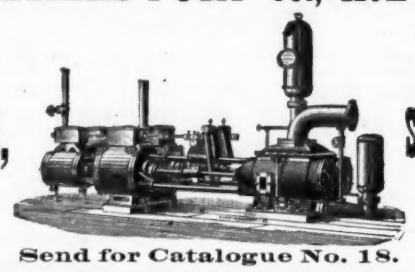
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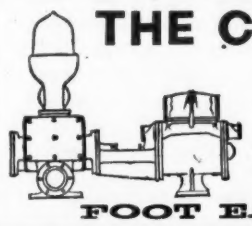

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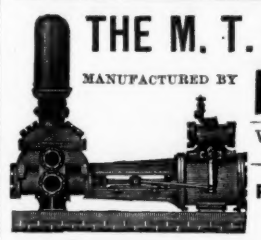
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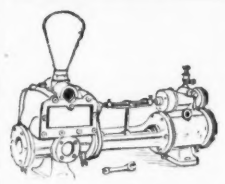
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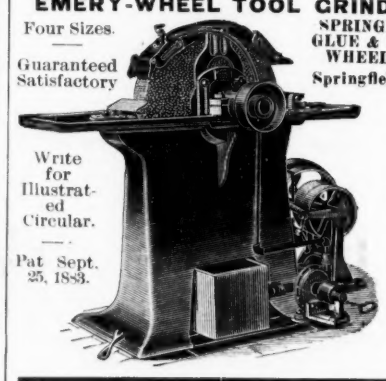
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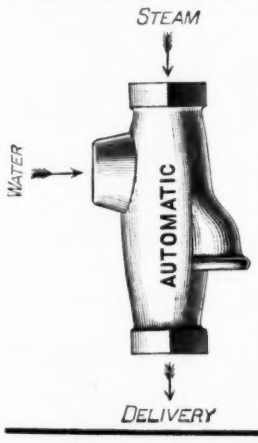

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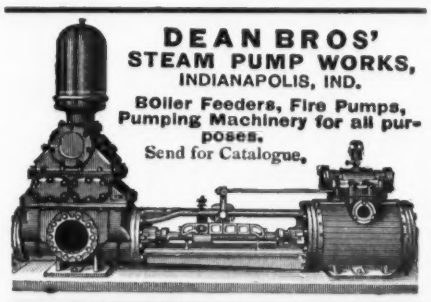

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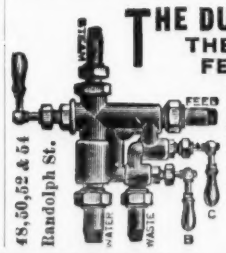

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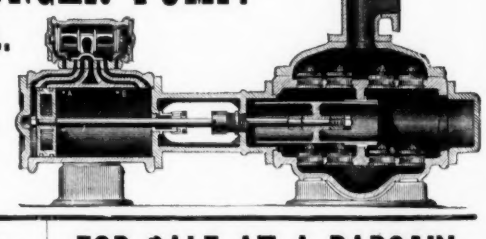

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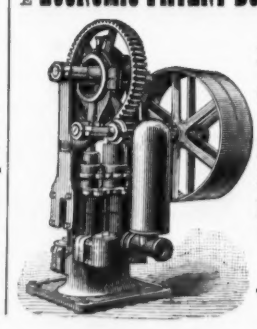

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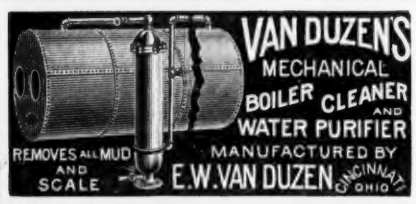

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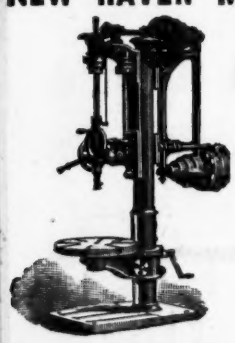

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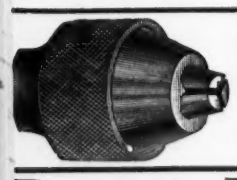

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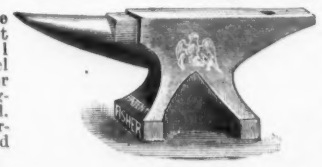

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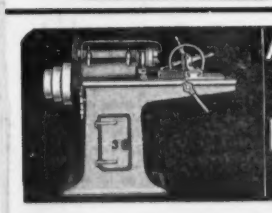

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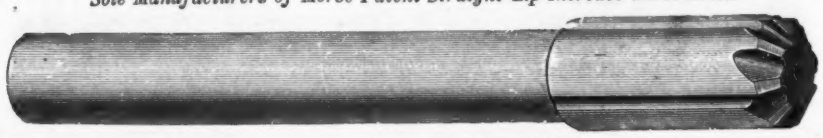

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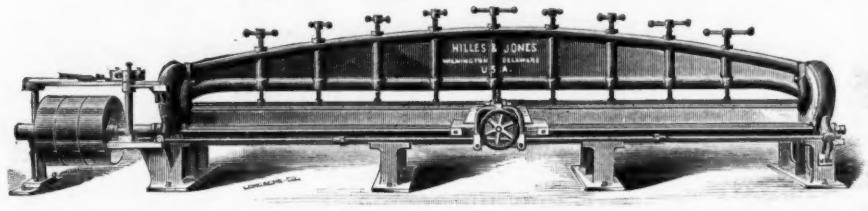

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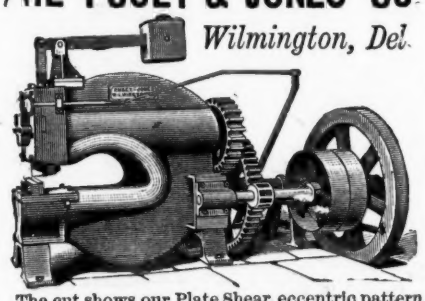

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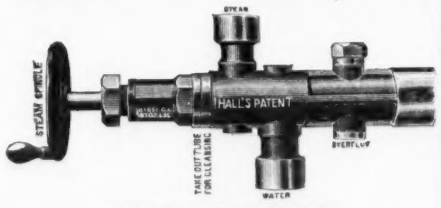

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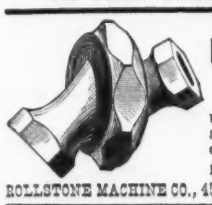

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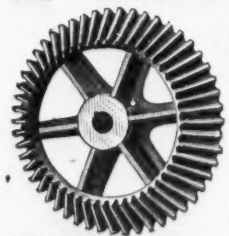

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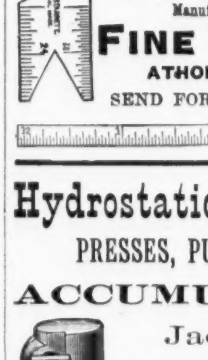

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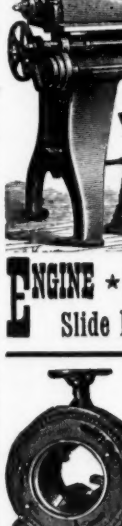

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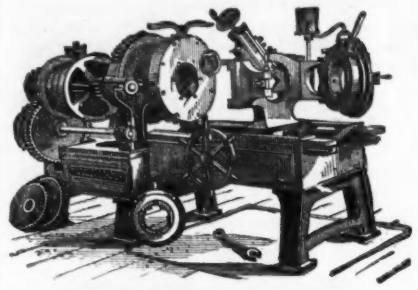

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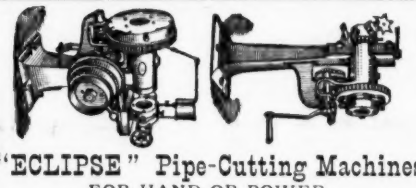

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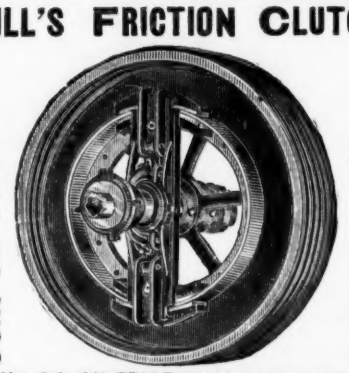

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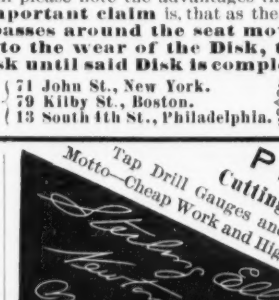

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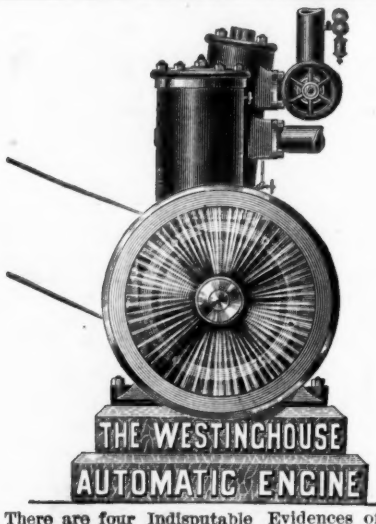

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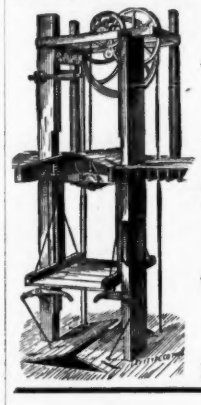

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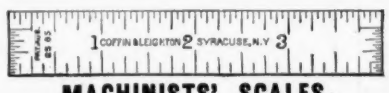

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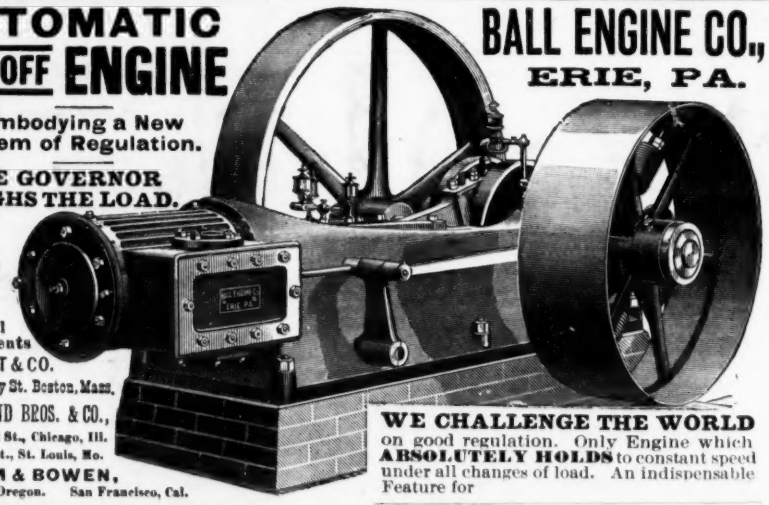

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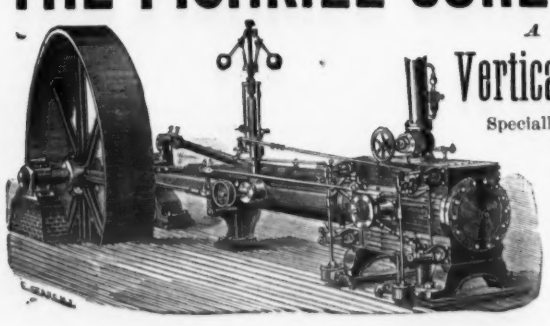

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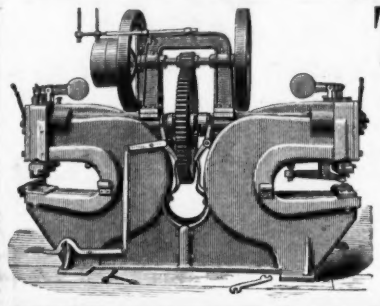

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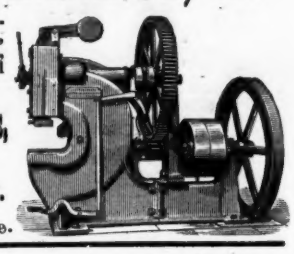

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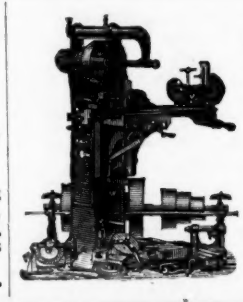

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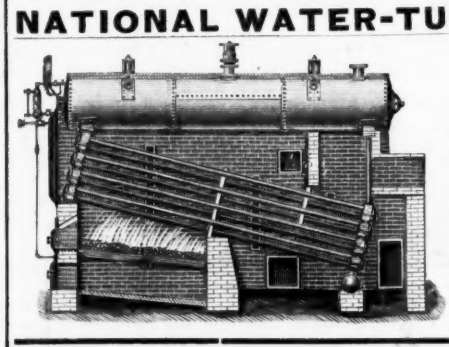

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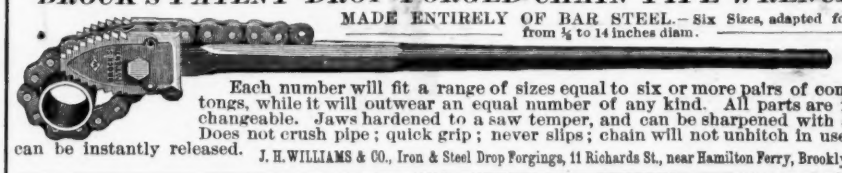

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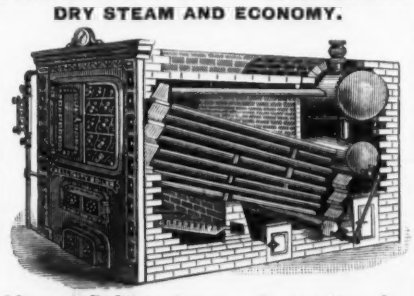

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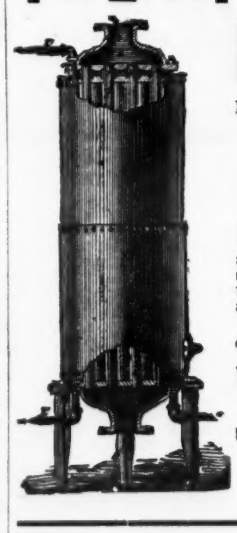

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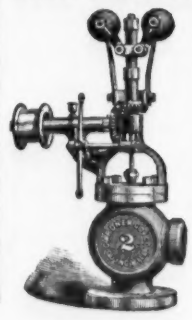

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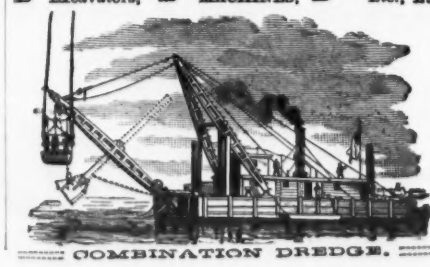

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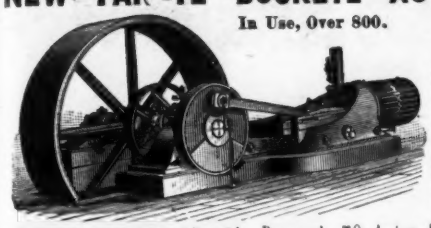

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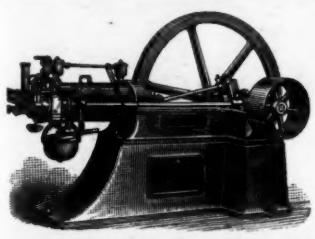

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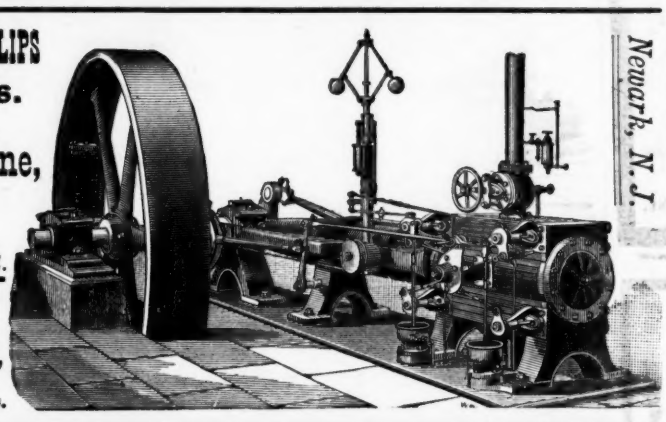

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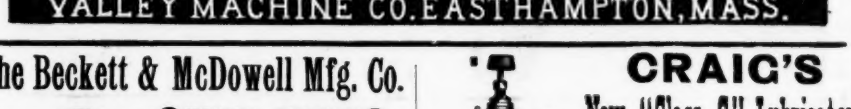

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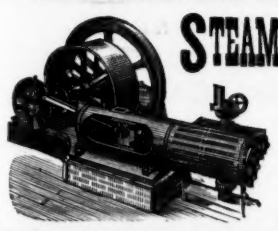

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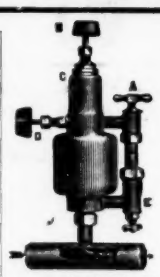

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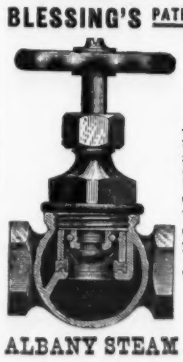

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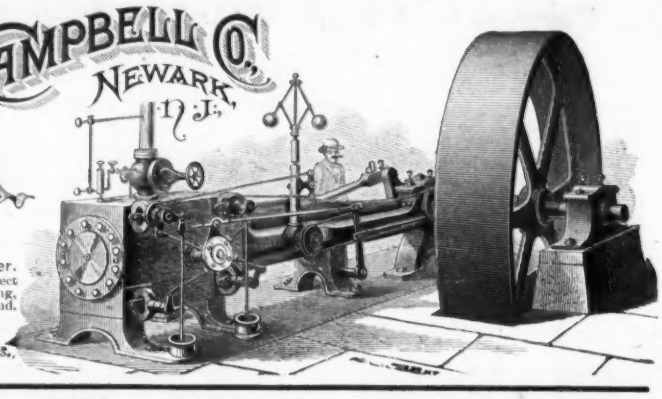

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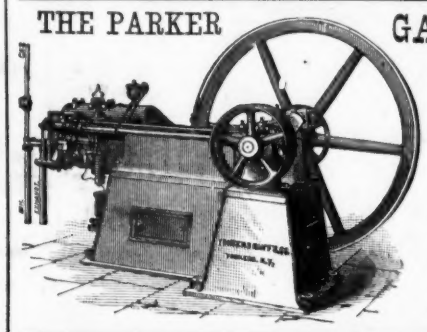

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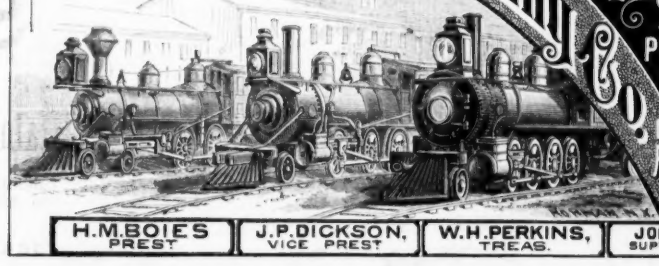

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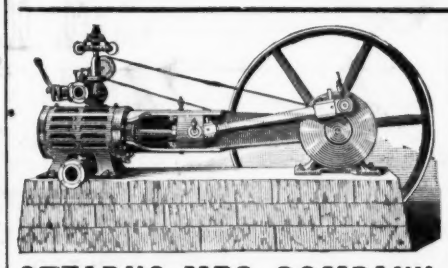

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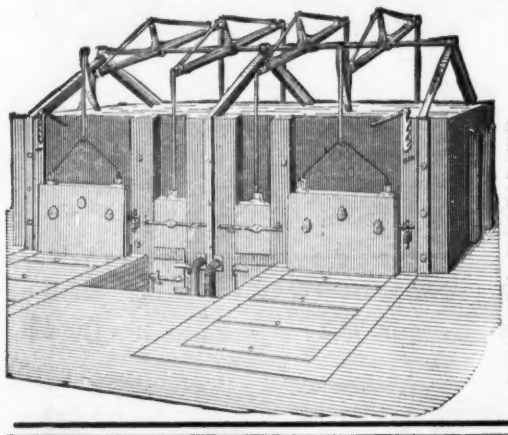

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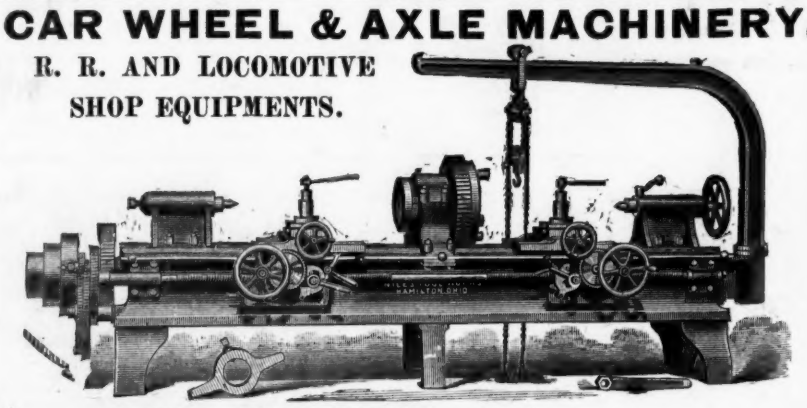

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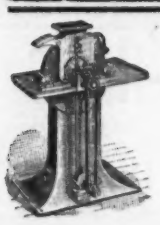

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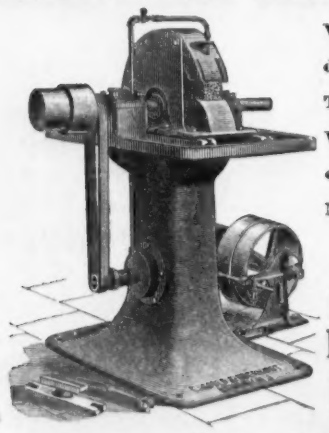

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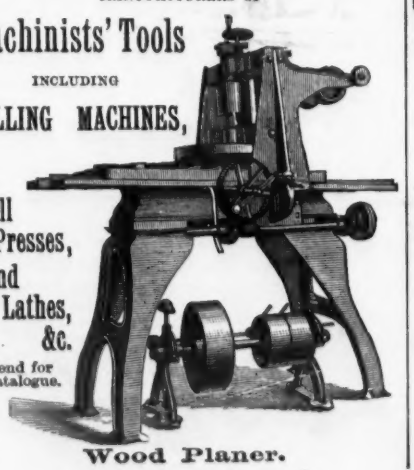

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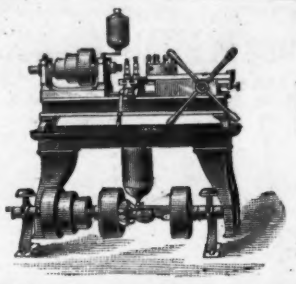

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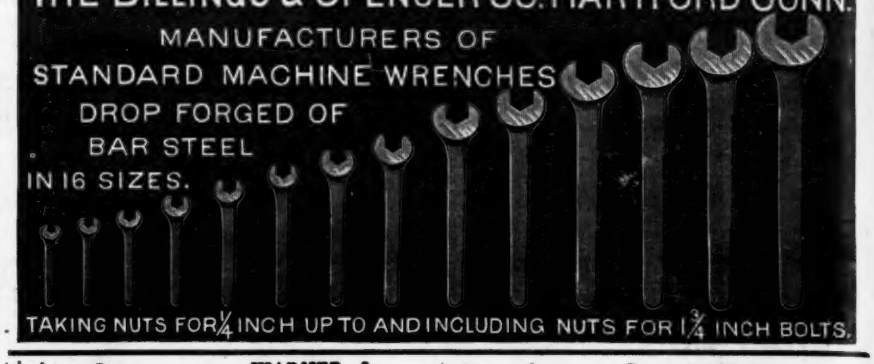

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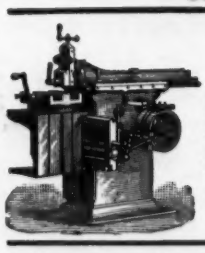

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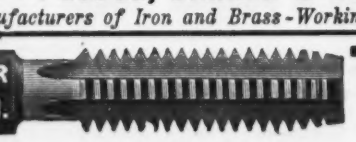

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